Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

UNITED STATES DEPARTMENT OF AGRICULTURE
BULLETIN No. 726
OFFICE OF THE SECRETARY
Joint Contribution from the Office of Farm Management
W. J. SPILLMAN, Chief
and
Bureau of Plant Industry
W. A. TAYLOR, Chief

Washington, D. C. ▼ December 14, 1918

FARM PRACTICE IN GROWING SUGAR BEETS FOR THREE DISTRICTS IN COLORADO

1914–15

By

L. A. MOORHOUSE, Agriculturist, R. S. WASHBURN, Scientific
Assistant, and T. H. SUMMERS, Scientific Assistant,
Office of Farm Management
and
S. B. NUCKOLS, Assistant Agriculturist, Office of
Sugar-Plant Investigations, Bureau of Plant Industry

CONTENTS

	Page
Introduction	1
Summary	3
Method	4
Development of Industry	5
Climatic Conditions	7
Size of Farms	9
Relation of Beet Acreage to Irrigated Area	10
Crop Rotations	11
Man and Horse Labor	13
Farm Practice	14
Cost of Producing Sugar Beets	45
Profit	50
Summary of Costs by Tenure	51
Cost in Relation to Acreage and Yield	52
Value of Beet Tops	55
Relative Importance of Beet Receipts	56
Variations in Farm Practice	56

WASHINGTON
GOVERNMENT PRINTING OFFICE
1918

UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 726

Joint Contribution from the Office of Farm Management,
W. J. SPILLMAN, Chief, and Bureau of Plant Industry,
W. A. TAYLOR, Chief.

Washington, D. C. ▼ December 14, 1918

CONTENTS.

	Page.
Introduction	1
Summary	3
Method	4
Development of industry	5
Climatic conditions	7
Size of farms	9
Relation of beet acreage to irrigated area	10
Crop rotations	11
Man and horse labor	13
Farm practice	14
Cost of producing sugar beets	45
Profit	50
Summary of costs by tenure	51
Cost in relation to acreage and yield	52
Value of beet tops	55
Relative importance of beet receipts	56
Variations in farm practice	56

INTRODUCTION.

The data presented in this bulletin are based upon 371[1] farm estimates[2] obtained from representative sugar-beet growers in four counties in Colorado, viz, Otero, Morgan, Larimer, and Weld (fig. 1). These estimates are for the crop years 1914 and 1915. Agricultural conditions were approximately normal during this period.

While four counties were included in this survey, the records have been worked out in three distinct groups. The agricultural conditions in Weld and Larimer Counties were found to be very similar, hence it was thought that in this study these two areas could be combined to advantage (referred to in this bulletin as the Greeley district). Conditions prevailing in Morgan and Otero Counties were such, however, that it seemed desirable to work out the reports for these districts separately (referred to, respectively, as the Fort Morgan and Rocky Ford districts).[3]

---

[1] Some of the tables that are presented in this bulletin apply only to the crop year 1915. Four farm records, within the total number, contained complete notes and data on field practice, but they did not afford full information concerning all of the cost factors. Several of the summary tables are, therefore, based upon 367 records.

[2] This is the second of a series of bulletins giving the results of an investigation relative to the practice and cost of growing sugar beets in four of the most important sugar-beet areas in the United States. The practice and cost of growing beets in California and Michigan will be treated in later publications.

[3] The Office of Farm Management and the Office of Sugar Plant Investigations, Bureau of Plant Industry, cooperated in taking the farm records. The latter office was interested in securing a detailed account of the farmer's method of growing this crop. It was thought that these data would be of very great value in planning agronomic experiments for the purpose of solving some of the urgent problems that have arisen in areas where the sugar beet is cultivated. Acknowledgment is due to the farmers in these districts who gave willingly of their time in order to provide complete information concerning their field methods and also the details of their farm business, so that certain economic phases might be studied thoroughly. Acknowledgment is also due Dr. A. L. Thomson, expert, Joe G. Lill, assistant, and James W. Jones, agriculturist, who assisted in collecting field data.

During the years 1916–17, labor costs advanced appreciably in this region, and there was a corresponding increase in the cost of materials used in growing the sugar beet. This upward trend was also reflected in some of the other costs considered in this bulletin. In view of these changes, since the dollar is a fluctuating measure, special attention has been given in this study to values that are known to be much more stable than money values. The hours of man and horse labor do not vary greatly from year to year; the quantity of seed used remains about the same; the application of manure or fertilizer is not likely to increase or decrease perceptibly under a given type of farming, and the quantity of other necessary supplies used will undoubtedly remain fairly constant, though the cost in money may not. Throughout this bulletin the emphasis has been placed upon these items, and money costs are referred to only incidentally.[1]

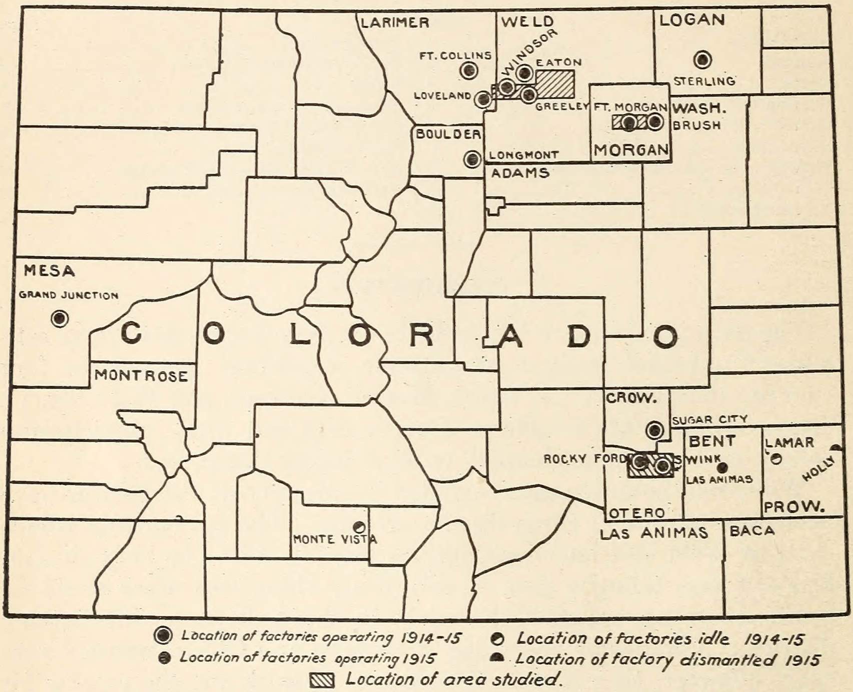


FIG. 1.—Map showing the three districts included in this survey, and location of the sugar factories of Colorado.

---

[1] Farm practice studies were begun in the sugar-beet sections of Colorado during the summer of 1910. Prior to this date reports had been received from several areas to the effect that difficulties were being met in securing satisfactory yields, and requests for assistance were brought to the attention of the Secretary of Agriculture. The problems under consideration involved not only the production of sugar beets but were also related to other important enterprises on these farms. It was felt, therefore, that a review of the practices on several of the successful as well as a similar number of the less remunerative farms in these areas would develop suggestions that might be helpful in this connection. This project was expanded in 1915 and arrangements were made to secure detailed records on the various items of cost that enter into the production of sugar beets. In order to get these data, it was necessary to make a careful analysis of the cultural treatment followed by individual growers in the three areas. While the primary object was to obtain cost figures, the development of the investigation has been such that it has been impossible to treat of costs without laying emphasis upon farm practice.

Field practice and related costs are controlled by several factors, some of the more important of which are: (1) season or climatic conditions; (2) soil type; (3) manurial practice; (4) methods of preparing the seed bed; (5) intertillage of the crop; (6) irrigation; (7) distance from market; (8) the efficiency of man and horse labor; and (9) crop yield.

By comparing the methods of field treatment in the Arkansas Valley with the methods that prevail in the Greeley area, it is found that in Otero County it is a common practice to irrigate land immediately after planting, while in Weld County the rainfall is usually sufficient to germinate the seed promptly, so that early spring irrigation is omitted. Season or climatic conditions in this particular case impose additional work upon the operator who is producing beets in the Arkansas Valley. Again, the soil type influences the amount of work required to bring the land into first-class condition for seeding. A heavy clay soil is much more difficult to handle than a type like the Colorado sandy loam, and additional field work means an increased cost. The same feature may be illustrated in methods of fertilizing the soil, or in the preparation of the seed bed, or in the cultivation of the crop. Investigations in other areas have emphasized the fact that the crop yields have a very important bearing upon cost.

Thus it will be seen that there is necessarily considerable variation in the practice of growing sugar beets, and this, in turn, enters into cost of production. A figure that may be applied to a given farm in a typical beet area may not be applicable to the adjoining farm. Likewise, a district average may be higher or lower than the cost of growing this crop in an adjacent district or in a bordering State. It is certain that a cost figure can not be used which will answer for the country as a whole. The best that can be accomplished in making these calculations will be found in a discussion of figures that can be used in a relative way. Having full information concerning the practice under which these costs were ascertained, the grower will be able to see wherein his methods coincide and wherein they differ from the record which has been compiled. By weighing each operation carefully, it will be possible for him to reach an estimate which should cover the requirements of his farm.

SUMMARY.

1. A review of the farm practice outlined in this study shows that the acre costs for all tillage operations for sugar beets performed by the operators, with the exception of plowing, rolling beets, irrigating, hoeing, and topping, were lower for the farms studied in the Greeley and Fort Morgan areas than for those at Rocky Ford. This was

due mainly to the heavier soil types at Rocky Ford, which necessitated a greater amount of tillage.

2. Labor, including man, horse, and contract labor, was the most important charge. It varied from 54.3 per cent to 59.1 per cent of the total cost.

3. Charges for materials, such as seed, manure, and water, varied from 8.6 per cent to 10.7 per cent of the total cost of production.

4. Other costs, such as interest on land for owners and land rental for tenants, insurance, taxes, and machinery, made up 32.3 per cent to 35 per cent of the total cost of raising this crop.

5. The total cost of production per acre in 1914 and 1915 was $72.53 in Greeley, $65 at Fort Morgan, and $64.87 at Rocky Ford. The total receipts per acre, including tops, amounted to $92.44 at Greeley, $81.66 at Fort Morgan, and $67.36 at Rocky Ford. The average yield for the Greeley area was 15.57 tons per acre, for Fort Morgan 13.65 tons, and for Rocky Ford 12.99 tons.

6. Farm owners produced beets at a lower cost per acre and per ton than tenant operators, with the exception of the Rocky Ford area, where the owners had the higher acre cost and a higher cost per ton. That it was possible for owners in the Greeley area to produce beets at a lower cost than the tenants was due chiefly to the fact that the interest charge on beet land in the owner group in 1914 and 1915 was much less than the corresponding rental charge on tenant farms.

7. Seventy-four per cent of the farmers fed beet tops directly to their own stock, 12 per cent fed a portion and sold the remainder, and 14 per cent sold all tops. The estimated farm value, $3.35 per acre, for beet tops was 28 cents per acre greater than the actual selling value in the districts under observation.

8. Since the cost of production per ton of sugar beets decreased as the yield increased, any change in the methods of sugar-beet growing which does not violate the principles of good farm management, and which will increase the tonnage per acre without materially increasing the cost of production, should receive the attention of sugar-beet operators in these areas.

METHOD.

The tables that are presented in this bulletin were not taken from systematic records kept on farms, but are based upon a large number of detailed reports given by beet growers on the 1914 and 1915 crops. The results represent the best judgment and experience of men who have been producing this crop for several years. During the year 1914 the field records were confined entirely to cost studies. In other words, the schedules, which were filled out by well-trained enumerators, contained only the items necessary to the compilation of cost data. In 1915 a combination survey and enterprise blank was used. This record form not only provided complete information pertaining to farm practice and farm costs in the production of sugar beets, but it also furnished data showing the outcome of the entire farm business for the crop year. The latter additions made it possible to compare the sugar-beet enterprise with other important farm enterprises.[1]

DEVELOPMENT OF INDUSTRY.

The building of a factory at Grand Junction in 1899 marked the beginning of the beet industry in Colorado. The Twelfth Census, taken that year, shows that 169 farms in Colorado reported on sugar-beet acreage. The total acreage grown was 1,094, producing a total of 6,656 tons, with a yield of 6.1 tons per acre. These estimates indicate an average of approximately 6.5 acres per farm. This acreage was produced largely in Mesa County, on the western slope.

Ten years later (Thirteenth Census) the acreage devoted to beets had increased to 108,082, with a total production of 1,231,712 tons, an average yield of 11.4 tons of beets per acre. Weld County occupied the first place in beet acreage in 1909, Larimer County second, Otero County third, and Morgan County fourth. Government estimates for 1915 indicated that this acreage had been increased to 160,800 for the State, with a prospective return of 1,706,300 tons, or an average of 10.6 tons per acre.

The beet-sugar factory at Rocky Ford was erected in 1900. This was the first plant to be installed in the Arkansas Valley. Five other factories have been added since 1900. In the northern part of the State the first sugar factory was erected at Loveland in 1901. By the year 1906, eight other factories had been built in northeastern Colorado (fig. 2).

The acreage and yield per acre for the sugar-beet crop in the areas surveyed will be found in Table I. While these figures cover only five seasons, they indicate that some increases in acreage have been made within the last few years.

---

[1] Studies which have been made by the Office of Farm Management indicate that the survey method of securing information used in this study furnishes very reliable results when enough records have been tabulated. This point is illustrated in the following table.

A comparison of farmers' estimates with factory records, crop year 1915, average per farm.

District.	Number of farms.	Acres in beets.		Tons per acre.		Total receipts.	
		Estimate.	Factory.	Estimate.	Factory.	Estimate.	Factory.
Greeley	90	26.1	25.5	15.5	14.6	$2,355	$2,236
Fort Morgan	66	37.1	36.0	13.5	13.2	2,897	2,754
Rocky Ford	37	22.3	21.8	11.7	11.2	1,429	1,335

This report is based on the records that were taken for the crop year 1915. The previous year's work was checked in a similar manner, though in one of the districts studied several growers sold to more than one company, so that complete reports were not secured for all farms. Taking the above groups as a whole, there was a tendency to report the acreage and yield a little above the actual acreage and returns.

TABLE I.—*Acreage and yield of sugar beets as reported by factories for five Colorado districts.*

[Data provided by Colorado beet sugar companies.]

Year.	Rocky Ford.		Fort Collins.		Greeley.		Eaton.		Fort Morgan.	
	Acreage.	Tons per acre.	Acreage.	Tons per acre.	Acreage.	Tons per acre.	Acreage.	Tons per acre.	Acreage.	Tons per acre.
1911	7,213	10.74	8,087	10.90	6,340	13.33	4,501	13.76	3,283	12.25
1912	10,925	11.89	12,348	10.09	10,089	12.07	10,451	15.40	5,155	12.24
1913	13,879	10.63	14,289	11.07	11,411	12.05	16,597	13.13	6,969	10.21
1914	11,208	12.39	11,900	13.02	8,892	12.74	11,547	13.22	6,575	13.01
1915	13,560	11.59	13,529	12.15	15,232	12.35	12,081	12.55	9,450	10.68
Average	11,356	11.45	12,031	11.89	10,393	12.42	11,035	13.50	6,286	11.48

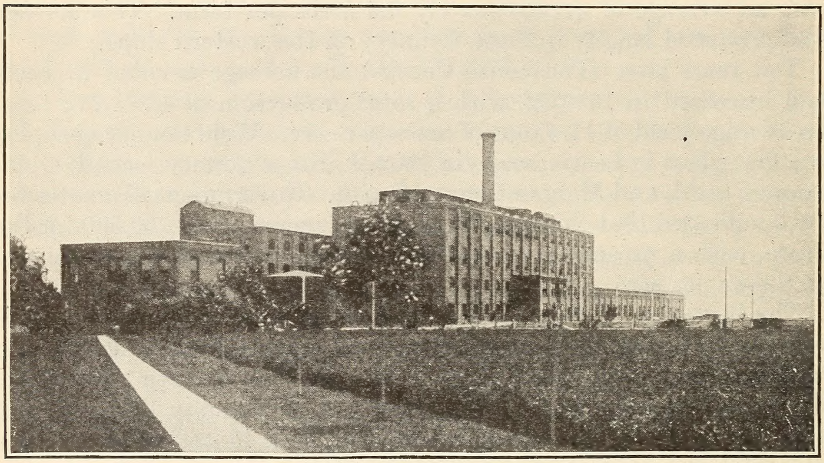


FIG. 2.—One of the beet-sugar factories in northeastern Colorado. This plant, constructed in 1905, has a rated capacity of practically 1,000 tons daily.

The lowest average yield for the five-year period was recorded in the Rocky Ford district, although there is little variation in the average yields for the Fort Collins, Fort Morgan, and Rocky Ford areas. The average yield for the Rocky Ford area during the years 1914 and 1915, when the enterprise records were obtained, exceeded the normal yield. The maximum average yield was obtained in the Eaton district. A large number of the enterprise records for Weld County came from the Eaton area. Fort Collins and Fort Morgan were considerably above the normal for the year 1914. The latter was slightly below normal in 1915. On the whole, there were no wide differences in yield within the groups. The slight fluctuations that may be observed were undoubtedly due to climatic conditions.

CLIMATIC CONDITIONS.

The climate of Colorado is semiarid. To obtain maximum yields under semiarid conditions irrigation must be practiced. While it is possible to grow certain crops under dry-farming methods, some important staples, such as the sugar beet, are confined entirely to the irrigated valleys (fig. 3).

The three distinct areas in Colorado where farmers give considerable attention to beet culture are in three more or less extensive drainage basins, namely, the South Platte River and its tributaries, the Arkansas Valley, and the western slope. This bulletin is concerned with the first two areas. Rocky Ford was selected as a typical area in the Arkansas Valley. Fort Collins, Greeley, and Fort Morgan are important beet-growing centers adjacent to and in the valley of the South Platte.

TABLE II.—*Average annual rainfall for three districts in northeastern Colorado and one district in the Arkansas (Valley in inches).*

	Rocky Ford, 1889–1908.	Fort Collins, 1873–1908.	Greeley, 1888–1908.	Fort Morgan, 1889–1908.
	Mean.	*Mean.*	*Mean.*	*Mean.*
January	0.32	0.49	0.34	0.26
February	.34	.52	.37	.31
March	.68	.98	.81	.69
April	1.66	2.23	1.82	1.77
May	1.92	3.06	2.61	2.42
June	1.35	1.59	1.33	1.75
July	2.76	1.90	1.80	2.41
August	1.37	1.21	.97	1.56
September	.78	1.16	.82	.70
October	.90	1.02	.82	.80
November	.46	.33	.33	.30
December	.44	.32	.25	.29
Total annual precipitation	12.98	14.81	12.27	13.26
Elevation feet	4,177	4,985	4,639	4,338

Precipitation and seasonal distribution of rainfall are much the same for the four counties. The major portion of the annual rainfall occurs during the growing season. Generally speaking, the rainfall for April, May, and June is somewhat lower at Rocky Ford than at the other points, which accounts partially for the fact that it is customary there to irrigate immediately after planting, whereas in northern Colorado the grower invariably counts upon starting the crop with the spring precipitation.

The light rains which fall during July, August, and September do not benefit the crops greatly. In fact, they may do serious damage either by crust formation or by simply sprouting the seed without furnishing moisture enough for a satisfactory subsequent growth. The late fall and winter months are marked by few light rain or snow storms. The water which falls from November to March is probably sufficient one season in four to provide some moisture for crop production. When the winter rains are light, the fields remain hard and dry and are in poor condition in the spring unless irrigated thoroughly during the late fall or early winter.

The Greeley district lies close to the mountain range and the mean annual temperature there is 47° as compared with 51° at Fort Morgan. The range between extremes is wide, 100° being frequently reached in the summer season. The nights, however, are cool. The summer temperatures for the Rocky Ford district are somewhat higher than those recorded for the other districts included in this survey. Throughout the entire territory cloudy days are the exception.

FIG. 3.—Irrigation canal No. 2 in the Greeley district.

High winds are a characteristic feature of the region, and they usually blow with greatest persistence in the spring, when the fields are without vegetation. Thus it is a common occurrence for loose soil to be picked up and carried along with each strong current of air. If the young beet plants are still small and tender when the winds are high, considerable damage may be done to the crop by the moving soil. It is sometimes necessary to reseed large areas, owing to the fact that the plants from the first seeding have been destroyed by a wind storm. Only in some of the older districts has this difficulty been reduced by the growing of windbreaks.

SIZE OF FARMS.

The latest information available on size of farms in these districts is found in the report of the census for 1909. These figures have been incorporated in Table III, together with a distribution of the farms covered by this survey.

TABLE III.—*Number and size of farms in Larimer, Weld, Morgan, and Otero Counties; also number and classification of farms giving records.*[a]

Size of farm.	Larimer County.		Weld County.		Morgan County.		Otero County.	
	Thirteenth Census.	Survey records.	Thirteenth Census.	Survey records.	Thirteenth Census.	Survey records.	Thirteenth Census.	Survey records.
Under 3 acres	11	None.	6	None.	0	None.	16	None.
3 to 9 acres	121	None.	72	None.	28	None.	85	None.
10 to 19 acres	111	1	64	None.	23	None.	102	2
20 to 49 acres	204	12	181	9	42	4	326	33
50 to 99 acres	294	12	715	44	140	20	311	40
100 to 174 acres	559	26	1,846	49	450	29	438	27
175 to 259 acres	159	13	344	16	83	9	77	5
260 to 499 acres	204	9	626	4	255	3	105	3
500 to 999 acres	73	None.	81	None.	36	1	20	None.
1,000 acres and over	94	None.	46	None.	18	None.	18	None.

[a] The figures reported under Thirteenth Census were obtained by the Census Bureau and are applicable to the year 1909. The numbers that are included under "Survey records" apply to the farms used in this survey.

In all districts studied, according to census figures, the largest number of farms in any of the size groups falls between 100 and 174 acres, including 160-acre, or "quarter-section" farms. While it is customary to think of irrigation farming as more or less intensive, nevertheless it is a fact that there are comparatively few small farms in these districts.[1] In Morgan, Otero, and Weld Counties there is found a fair proportion of farms containing 80 acres.

When irrigated farms of this type are placed in contrast with farms of similar size in the humid belt, assuming that the groups are similar in every other respect, it will be found that much more labor is required to carry on the operations under irrigation than without.

Each of these counties has an extensive area devoted to dry farming, as may be inferred from the number of very large farms. Under this system these larger farms can be utilized to advantage. Small grain growing is the most important industry on this particular type of farm. Some corn is grown. A portion of this land is known as open range, and is devoted to pasture.

---

[1] It will be seen that each of the counties included in this study has a certain number of farms containing 9 acres or less. Sugar beets are grown on these tracts, but in making this investigation it was thought that the very small farms ought not be considered in making up the estimates. Usually, the acreage devoted to beets in these small units is much less than 5 acres. The man who produces less than 5 acres of sugar beets does not have enough work on such major operations as harrowing, disking, floating, planting, or cultivating to keep the horses employed for any considerable length of time, and it is therefore a difficult matter for him to estimate a day's work for such operations.

RELATION OF BEET ACREAGE TO IRRIGATED AREA.

It is a question whether the ideal rotation area for sugar beets can be given. There is no doubt a theoretically correct relationship between the areas devoted to the important staples in a given district, and this balance may be approximated on some farms each year. In a district where the various enterprises are well established the ideal cropping system may be more nearly approached than in sections where there is considerable change in the selected list from year to year. This study does not attempt to answer the point at issue, but it does show the average conditions that existed on these farms at the time of the survey.

Under the system of general farming that prevails in the Fort Morgan and Rocky Ford districts it appears that the list of leading crops is smaller than in the Greeley area. The Fort Morgan records indicated three staples, namely, alfalfa, beets, and barley, whereas in the Greeley section the list included alfalfa, potatoes, sugar beets, and spring wheat or barley. This brief discussion may therefore explain, in part, the difference of 10.6 per cent between the percentage of irrigated land in beets at Greeley and the percentage at Fort Morgan (Table IV).

TABLE IV.—*Average farm area, tillable area, irrigated area, acres in beets, and per cent of irrigated land in sugar beets.*

District.	Number of farms.	Acres per farm.	Acres tillable.	Acres irrigated.	Acres in beets.	Per cent of irrigated land in beets.
Greeley	195	136.40	112.39	107.40	25.72	24.0
Fort Morgan	66	143.40	113.59	107.55	37.20	34.6
Rocky Ford	106	92.33	70.72	65.77	22.91	34.9

SOIL TYPES.

The counties included in the beet-growing districts afford a large number of soil types for comparison. Two surveys have been made in these districts by the Bureau of Soils of the United States Department of Agriculture.[1] In the Rocky Ford area there are two important soil types, namely, Maricopa sandy loam and Fresno fine sandy loam. These two constitute approximately 70 per cent of the area mapped in the Arkansas Valley. The Fresno fine sandy loam has a fine sandy or silty texture, is yellowish in color, and extends to a depth of 6 feet. It is comparatively rich in plant food, but is sometimes deficient in organic matter. It is well adapted to such staples as alfalfa, sugar beets, melons, and grain, is easily tilled and can be maintained in first-class condition without an undue amount of work. The Maricopa sandy loam has a much more open texture than the former type, and it absorbs moisture readily. The compact structure of the subsoil has a tendency to retard the movement of seepage water from canals and ditches. This soil is well suited to the production of the staple crops that are grown in the valley.

---

[1] Soil Survey of the Lower Arkansas Valley, Colorado, by H. Lapham and party, 1902. Soil Survey of the Greeley area, Colorado, by J. Garnett Holmes and N. P. Neill.

The prevailing soil type in the Greeley area is the Colorado fine sandy loam. It consists of a fine sandy loam, with a depth of 3 feet and is underlain by a heavier fine sandy loam. As the depth increases the proportion of silt and clay becomes greater. This formation has good drainage and the type is therefore quite free from seepage water. It is a good potato soil and is well suited to such crops as alfalfa, sugar beets, peas, beans, and grain. A review of the soils in this region will show that they grade from the more open type, known as the Colorado sand, to the exceedingly heavy type designated as Colorado adobe. While the agricultural methods which are followed on the different types may correspond in some respects, it will be entirely correct to say that considerable work is usually required to bring these types into the proper condition for planting seed, and greater care must be exercised in connection with intertillage and irrigation. These precautions with the extra work necessarily involve additional expense in the production of sugar beets.

CROP ROTATIONS.

Crop rotations in the irrigated districts of Colorado have been improved and strengthened very materially within the past 20 years. The evolution of these systems has taken place during the past 50 years or more. The race for gold brought a large number of settlers into Colorado in the early sixties. A few of these men were successful, others were less fortunate, and still others failed. There was practically no farming population at that time, and provisions had to be brought in from the outside. High prices prevailed. Men who had come from the farms of the East or Central West and who were disappointed in the results of their mining operations turned to farming for a living. The valleys to the east and north of the gold fields attracted them. They discovered that vegetables of good quality could be grown on these lands. The wild hay along the streams furnished roughage for farm stock. The salable products brought remunerative prices. Flour was in demand. Wheat growing became therefore one of the important enterprises of the farm during that early period.

It will be seen that a complete cropping system could not have been developed immediately, nor was it possible to determine at once the type of farming that would give the best returns. The grower did not have information concerning the adaptability of various crops, and special types of farming to meet the new conditions had not yet been evolved. Field experience had to be accumulated before any advanced steps could be taken.

Prior to the year 1885 comparatively few men had set aside part of their land for alfalfa, though the continued culture of wheat had reduced the supply of organic matter in the surface soil and a change in the method of cropping appeared to be essential. During this early period it was not thought that alfalfa could be used in a regular rotation. This plant possessed a long tap root and farmers had the opinion that the crop could not be subdued readily. However, the pioneer in this field soon demonstrated that alfalfa had many advantages, and before many years had passed it was recognized as a basic crop in the rotation. In all of the counties which were included in this study a considerable acreage is devoted to this legume. Alfalfa is the initial crop in the typical rotations that have been adopted in these regions, as will be seen from the following outline of cropping systems for four sugar-beet districts:

No. 1.—Rocky Ford.	No. 2.—Greeley.	No. 3.—Fort Collins.	No. 4.—Fort Morgan.
Alfalfa, 3 to 5 years. Cantaloupes, 1 year. Beets, 2 years. Cucumbers,1 year. Grain, 1 year.	Alfalfa, 3 to 4 years. Potatoes, 1 year. Beets, 2 years. Beans or peas, 1 year. Grain, 1 year.	Alfalfa, 4 years. Grain, 1 year. Beets, 3 years. Grain, 1 year.	Alfalfa, 4 years. Beets, 3 years. Grain, 1 year.

The rotation given for the Rocky Ford district (No. 1) serves merely as a type. Many of the estimates obtained in this district did not provide any information on rotations. The form given has been adopted on several farms and has proved to be a very satisfactory system. The alfalfa is broken out early in the spring, after which either cantaloupes or cucumbers are planted. A crop of grain sometimes follows the alfalfa. In some cases beets are planted on the newly broken alfalfa field. A few men stated that the alfalfa was allowed to remain down for an indefinite period, the remaining crops being rotated on the land under cultivation.

In the Greeley area (rotation No. 2) 75 per cent of the reports show that potatoes were planted as the first crop immediately after breaking alfalfa. A few men put in potatoes two years on the same land. In a few cases peas or beans followed potatoes, then beets were grown for one to two years, grain being sown the fourth year after breaking, and the field reseeded to alfalfa. Farm practice studies show that potatoes serve as a better crop to follow alfalfa than sugar beets. The alfalfa roots interfere too much with the early cultivation of the latter crop. Approximately 15 per cent of the farms used the sugar beet as the first crop after breaking. On some farms grain, cabbage, beans, peas, or corn is used to fill this place in the cropping series.

In the Fort Collins district the alfalfa is followed by a crop of grain, which assists in getting rid of the alfalfa roots and stems, so that beets can be grown to advantage the second year. This system (No. 3) is very popular outside of the potato district proper.

Rotation No. 4, the standard for the Fort Morgan district, differs slightly from No. 3 in that sugar beets follow alfalfa immediately after breaking. It should be stated, however, that approximately 15 per cent of these farms used a grain crop after breaking.

There are farms in all these areas where the sugar beet has been grown for a period of 1 to 10 years upon the same piece of land. It is, however, quite a general practice to employ a systematic rotation.

MAN AND HORSE LABOR.

Complete data were secured in each district with reference to the cost of man and horse labor. The man-labor rate was based on the average man-labor cost throughout the working season. Farm labor here can be divided into three classes, namely, regular labor, extra labor, and contract labor. The regular labor includes those who are given continuous employment; extra labor, those who are hired at certain busy periods during the spring and summer. On farms where a large percentage of the land is devoted to hoed crops, extra labor may be required to care for these fields. Then, too, the harvest season frequently demands additional help. Contract labor includes the men who are paid a stipulated amount to do certain tasks, such as the hand work on beets. As a rule, the rates for special labor are somewhat higher than the rates paid the regular labor.

The man and horse rates which are given in Table V are based upon records obtained during the years 1914 and 1915:

Table V.—*Average cost per hour of man and horse labor (1914–15).*

	Rocky Ford area (110 farms).	Greeley area (195 farms).	Fort Morgan area (66 farms).
	Cents.	*Cents.*	*Cents.*
Man	18	19	20
Horse	10	11	10

In working out costs, the operators in the respective districts have been given an arbitrary allowance of 18, 19, and 20 cents per hour for their work (see Table V), no charge being made to cover the general management of the farm.

The variation in labor rates was so slight that a uniform rate of 20 cents per hour for man labor and 10 cents per hour for horse labor might have been used to advantage in all of these sections. Labor rates may fluctuate greatly, but if the sugar-beet grower wishes to determine the cost of producing sugar-beets under new conditions it will only be necessary to calculate on the basis of actual time required to do the work.

The rates for horse labor were established in precisely the same manner as for the regular labor. It often happens that the operator is obliged to hire an extra team for rush work. The price which is paid is based usually upon the prevailing rate in the district. This furnished a very reliable guide for our calculations.

Contract labor takes care of such items as blocking and thinning, first and second hoeing, pulling weeds, and topping. On a few of these farms this work was done by the operator and his family. For the remaining farms, hands (often entire families) were engaged for the season. Fairly uniform acre rates have been established, though some variation may be found in comparing one district with another. In sections where a flat rate prevailed, the blocking and thinning rate was usually $6 per acre. The first hoeing cost $2 per acre, second hoeing $1 per acre, and the pulling and topping, together, amounted to $9 per acre, making a total charge of $18 per acre for the contract work or hand labor.

FARM PRACTICE.

REMOVING TRASH.

Some preliminary work is occasionally necessary, particularly on fields where vine crops have been grown or where potatoes with luxuriant tops have been produced. It may not be possible to incorporate the residue with the soil; consequently this material may either be placed in a composite heap to decay, or burned. There were only two records reporting work of this character. On one farm, at Greeley, removing a very small amount of residue cost but 12 cents per acre. On another, at Rocky Ford, where there was a heavy growth of vines to be removed, the cost was considerably greater than this. The true average labor requirement for this operation could not be determined with the limited number of records available.

SCRAPING THE LAND.

When new fields are brought under cultivation, some work is usually done with a scraper for the purpose of creating a level surface, thereby facilitating irrigation. Indeed, some scraping may be done occasionally on old fields in order to reduce knolls and perhaps to fill in low places. In this study scraping is considered as improvement work. Two records on scraping were obtained, in Weld County. The operation was performed on one of these farms by one man and two horses, at a cost of $1.03 per acre, and on the other by one man and four horses, at $1.26 per acre.

FARM MANURE.

The value of farm manure should not be based entirely upon the percentage of fertilizing constituents found therein. Especially is this true in the West, where with many soils the addition of humus is highly desirable. Indeed humus may be more beneficial to some of these soils than commercial plant food. Occasionally a Colorado beet grower is found who hauls manure to some out-of-the-way place instead of scattering it over his fields, but, as a rule, the value of this by-product is appreciated and a systematic effort is made to treat various portions of the farm in regular order. Invariably better yields are harvested after farm manure is applied, though it may not always be possible to determine the exact benefit that should be credited to the manure. Instances are on record where the yield of sugar beets has been raised from 9 or 10 tons per acre up to 16 or 18 tons per acre, apparently entirely through the application of manure. The nature of the subsoil is important in this connection.

Some of the farms, however, do not have a large supply of manure, and on such farms it is impossible to give each field a liberal application. Under such circumstances it may be advisable to supplement farm manure with green manure. The plan of turning under a substantial growth of alfalfa at least once in the rotation is a feature of farm management which deserves more than passing attention. The farmer who has followed this practice knows that better yields result, and he therefore has sufficient reason for maintaining the practice. To raise the standard of agricultural methods on the average farm in these districts the adoption of this plan is needed. There are several other crops which may be used for green manure. Sweet clover may be mentioned in this connection.

Ninety-two per cent of the men interviewed applied manure. They reported, not only on the time consumed in doing the work, but also on the fertilizing value of this by-product. In the majority of cases the manure was scattered on beet land. There were 310 growers who followed this practice. On 22 farms the manure was applied to potato land, on 5 to grain, and on 1 each to tomatoes, cabbage, and cantaloupes (Table VI).

In working out the labor cost for manure, a 50 per cent charge was made where the crop received direct benefit. If sugar beets were removed one crop year after the application of manure, 30 per cent of the labor was charged against the crop. When two seasons intervened between the manuring of the soil and the production of sugar beets 20 per cent of the labor cost was charged to beets.

Some hauled manure in the autumn, others throughout the winter, and still others in early spring, the work being done partly with spreaders and partly with wagons. The implements used in the Rocky Ford district were not indicated on every record; hence it was not possible to determine the number of men using manure spreaders there. Fifty-eight per cent of the Fort Morgan growers and 77 per cent of the Greeley farmers used spreaders.

TABLE VI.—*Data on use of manure for three Colorado districts.*

District.	Year.	Number of farms.	Acres manured.	Tons per acre.	Crew.		Hours per acre.		Total cost per acre.
					Man.	Horse.	Man.	Horse.	
Rocky Ford	1914–15	99	9.12	11.82	1.5	2.56	17.67	34.60	$6.64
Fort Morgan	1915	64	17.90	14.34	1.6	3.20	15.10	30.80	6.26
Greeley	1914–15	180	12.80	18.60	1.6	3.30	13.50	27.70	5.61

There was a decided lack of uniformity in all districts with reference to size of crew used in handling manure. One hundred and thirty-five growers, or approximately 40 per cent of the farms reporting, used one man and two horses. Rocky Ford had the largest proportion of this group. Taking all districts into consideration, there were 51 men who used a crew of one man and three horses to haul the manure, and 25 who hauled with a crew of one man and four horses.

On 105 farms an extra man was used to assist with the loading. The horse power was about equally divided between two, three, and four horse crews on these farms.

About 41 per cent of the land devoted to beets was manured in the Rocky Ford district, 47 per cent in the Fort Morgan district, and 49 per cent in the Greeley district. Rocky Ford had the lowest average application per acre, while Greeley had the highest. There was a difference of $1.03 per acre in the cost of putting on manure between these two districts. The advantage for Greeley was undoubtedly due to the use of larger crews.

CROWNING ALFALFA.

It has been pointed out that the sugar beet is not grown very generally after alfalfa. When this plan is followed two plowings are frequently necessary. The first operation is commonly known as "crowning alfalfa." This study contains 53 records which deal with crowning. On these farms only part of the beet crop followed alfalfa. "Crowning" is shallow plowing. In two districts this operation is known as "scalping the land." The average depth which was reported on these farms was about 3 inches. It will be seen that the plow was run deep enough to cut the alfalfa crowns from the long tap root. The beet growers in the Fort Morgan and Greeley districts, where the largest amount of this work was done, used a two-way plow almost exclusively. The two-way plow consists of two plows, only one plow being available for use at a time. It is possible with this type to eliminate back furrows and dead furrows, and the land is left with a smooth, even surface for subsequent tillage. The labor requirements and the cost of this operation in 1915 are shown in Table VII.

Table VII.—*Data on crowning alfalfa in three Colorado districts.*

District.	Year.	Number of farms.	Acres crowned per farm.	Crew.		Hours per acre.		Total cost per acre.
				Man.	Horse.	Man.	Horse.	
Rocky Ford	1915	7	7.2	1	3.57	7.3	26.2	$3.94
Fort Morgan	1915	28	14.6	1	3.50	4.6	16.2	2.65
Greeley	1915	18	12.8	1	3.30	4.87	15.8	2.67

The crowning was done partly in the fall of 1914 and partly in the spring of 1915. The major portion of this work occurred during the early spring months. There were 32 operators who used a crew of one man and three horses to do the crowning. On 16 farms a crew of one man and four horses was used. It cost $1.29 per acre more to do the work of crowning in the Rocky Ford district than in northern Colorado. The Greeley and Fort Morgan records did not differ materially in total cost for crowning.

PLOWING.

A limited area in these three districts was plowed during the autumn and early winter months. The heavier types of soil are benefited by exposure to the frosts of winter, and much less work is required to bring them into a mellow condition when fall and winter plowing can be done. Furthermore, the water-holding capacity of the soil is thus increased and more moisture is stored for the crop the following season. The rough broken surface also has a chance to become partially pulverized by the repeated freezing and thawing which occurs throughout the winter and early spring. If the work is postponed until late in the season the other farm operations will be delayed.

No implement has been devised that will take the place of the plow in the preparation of the seed bed for sugar beets. This tillage implement not only loosens the upper layer of soil and in turning the furrow slice pulverizes the particles of which it is composed, but it also covers and incorporates with this layer any manure that may have been scattered upon the field or any residue that may have been present at the time of plowing.

In the three districts studied the greater part of the plowing was done in the early spring. Five growers in northern Colorado stated that this work was performed in the autumn, seven men did part of the plowing in the fall and completed this operation in the spring, while the remaining records indicated spring plowing. Usually the marketing of beets continues late into the autumn months, and this interferes with fall plowing. More attention would undoubtedly be given to the latter if there were no interference with other work, such as digging potatoes or taking out and hauling beets from the farm.

There are some soil types which can be penetrated very readily by plant roots, and such soils may not require deep plowing. However, there are other types which are exceedingly close in texture and do not afford a suitable feeding area for crops like sugar beets unless plowed deep. Frequently the soil carries a fair proportion of cementing material which has a tendency to hold the particles together. Consequently the roots do not develop rapidly and a short, stunted beet is the result. The ideal crop can not be produced on soil that has an impervious subsurface. Deep tillage will open this layer and permit the plant roots to enter. An average depth of 5.8 inches was reached on the 104 farms reporting from the Rocky Ford district, 183 Greeley growers averaged 8.7 inches, while the 66 Fort Morgan operators plowed an average depth of 8.9 inches.

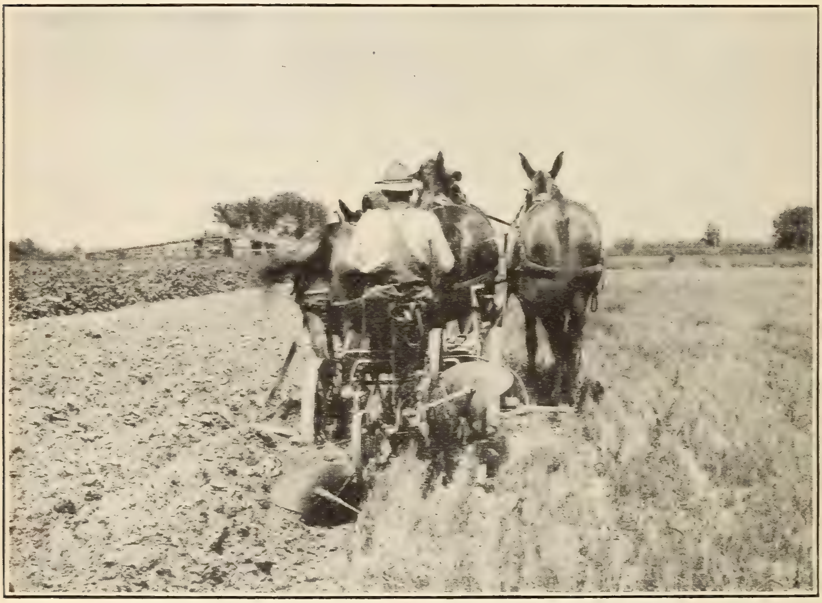


FIG. 4.—Fall plowing with a two way plow in the Arkansas Valley.

The two-way plow was used almost exclusively in northern Colorado, and it was mentioned in 41 per cent of the records from the Rocky Ford district (fig. 4). Sixty out of sixty-six farmers at Fort Morgan plowed with this type. For the Greeley area data on type of plow are incomplete. However, 53 per cent of all farms used the two-way type. The sulky plow with 14-inch or 16-inch bottom came second (fig. 5). Thirty-seven per cent of the Rocky Ford growers did the plowing with a sulky. Other types, such as the 14-inch walking plow and the two-furrow gang, appeared in scattered records.

TABLE VIII.—*Plowing data for three Colorado districts.*

District.	Year.	Number of farms.	Acres plowed per farm	Crew.		Hours per acre.		Total cost per acre.
				Man.	Horse.	Man.	Horse.	
Rocky Ford	1914–15	104	22.33	1	3.41	5.70	18.3	$2.86
Fort Morgan	1915	66	36.06	1	3.84	4.87	18.67	2.98
Greeley	1914–15	183	26.30	1	3.80	5.30	19.80	3.19

The crews for the respective districts varied somewhat in size. Sixty-three per cent of the Rocky Ford growers did this work with a crew consisting of one man and three horses, whereas 27 per cent plowed with one man and four horses. Fort Morgan reported 22 crews with one man and three horses, 32 crews with one man and four horses, and 12 crews with one man and five horses. In the Greeley district the crews were distributed as follows: Sixty-six crews of one man and three horses; 80 crews of one man and four horses; 32 crews of one man and five horses. There were a few crews of odd sizes. By taking the crews according to size and combining these for the three districts it was found that in 1914 and 1915 154 farmers with 1–3 crews plowed at an average cost of $2.60 per acre; 141 with 1–4 crews at an average cost of $3.30, and 45 with 1–5 crews at an average cost of $3.63.

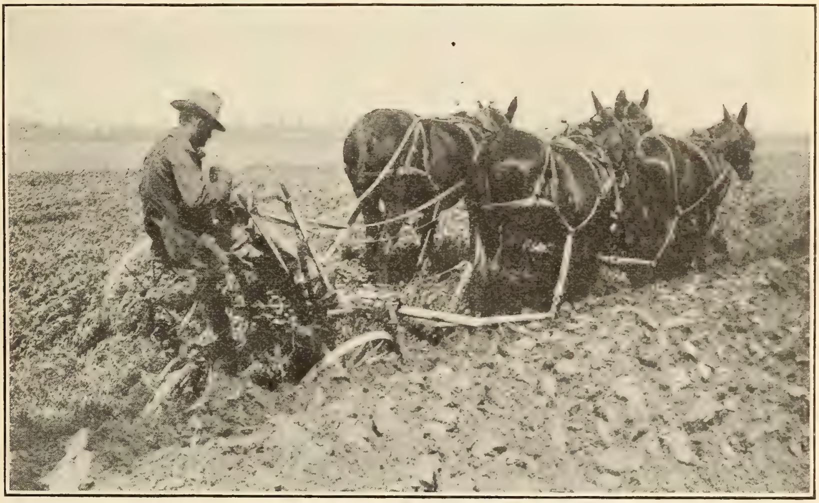


FIG. 5.—Breaking alfalfa with an ordinary sulky plow. This type in point of numbers stood second. On the above farm a considerable growth of alfalfa is being incorporated with the soil.

This does not necessarily mean that the large crews were less efficient than the crew consisting of one man and three horses. When the operator of a farm plans to increase the depth of his plowing, it is usually necessary to make provision for more horsepower. With the four- and five-horse crews it is altogether probable that the plowing was done somewhat deeper than on the group of farms using three horses per crew. An average day's work plowing varied from 1.7 acres to 2 acres for the different crews.

DISKING.

Occasionally some disking is done preparatory to plowing. Again, it is sometimes necessary to do the plowing when the soil is very dry. Consequently the surface may be left in a lumpy condition. The disk harrow can be run to advantage over such fields. This plan not only reduces the rough surface, but it also has a tendency to bring the soil back to the proper tilth. The disk stands second to the plow in effectiveness.

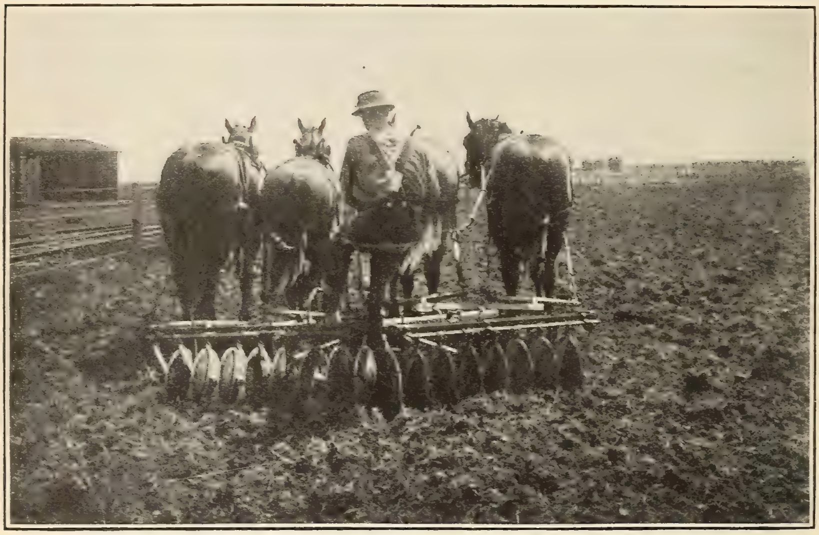


FIG. 6.—Disking land after plowing.

The field records show that much more disking was done in the Rocky Ford district than in either of the other sections under study. This may have been due to a heavier soil and climatic differences. (This feature will be discussed more fully under irrigation practice.) Disking was done at the same time as plowing, or later. The average width of disk used varied from 6.5 to 8.6 feet (fig. 6).

The prevailing crew for disking consisted of one man and four horses. Forty-three growers in Rocky Ford, 15 at Fort Morgan, and 15 at Greeley did the disking with a 1–4 crew. There were 15 farms at Rocky Ford that utilized a crew of one man and three horses. It cost 54 cents more per acre to do the disking at Rocky Ford than at

Fort Morgan (Table IX). The higher acre cost for the former area has undoubtedly been due to the fact that the disk was used more often there than at Fort Morgan.

TABLE IX.—*Disking data for three Colorado districts.*

District.	Year.	Number of farms.	Acres disked per farm.	Number times disked.	Crew.		Hours per acre.		Total cost per acre.
					Man.	Horse.	Man.	Horse.	
Rocky Ford	1914–15	61	20.24	2.3	1	3.65	2.52	9.20	$1.37
Fort Morgan	1915	19	31.3	1.6	1	3.80	1.40	5.18	.83
Greeley	1914–15	19	22.8	1.16	1	3.85	1.58	6.15	.98

Occasionally extra work is done on plowed land in order to accomplish some of the objects which have been referred to under disking. On all fall-plowed land weeds may appear early in the spring and some cultivation must be given in order to keep the field clean. In this study three farms were found that reported tillage operations not common to other farms. Two growers in the Rocky Ford district used the cultivator, followed by a clod masher. The operation was done in 1914 and 1915 with a crew of one man and three horses at a cost of 95 cents per acre. One farm in Weld County reported some special cultivation with a crew of one man and two horses, at a cost of 28 cents per acre.

LEVELING.

To insure a uniform distribution of water, the surface of the field must be smooth and free from depressions. The land leveler (fig. 7) accomplishes this result. It takes the soil from the tops of small knolls and deposits the material in any slight depressions that may exist. Some operators make a practice of leveling diagonally across the field, and if this process is repeated at right angles the surface is usually left without any serious inequalities. However, leveling also serves the purpose of a float, in that it crushes many of the small clods that are frequently present on the recently plowed field. Ninety-eight per cent of the growers who are referred to in this study reported on leveling, hence it will be seen that this practice was almost universal on these farms.

TABLE X.—*Leveling data for three Colorado districts*

District.	Year.	Number of farms.	Acres leveled per farm.	Number times leveled	Crew.		Hours per acre.		Total cost per acre.
					Man.	Horse.	Man.	Horse.	
Rocky Ford	1914–15	109	22.60	2.12	1	3.77	2.07	7.6	$1.13
Fort Morgan	1915	65	37.3	1.76	1	4.08	1.33	5.4	.84
Greeley	1914–15	188	25.54	1.51	1	3.87	1.23	4.7	.75

The leveling was done exclusively in the spring, the operation preceding planting at least ten days or two weeks. The implement varied in width from 8 to 10 feet. To do efficient work, the leveler must be of suitable length and should be heavy. In the Rocky Ford district the leveling was done with a crew of one man and four horses on 84 farms; 21 farms used a crew of one man and three horses. One man and four horses constituted the most important crew size at Fort Morgan. This was also true for the Greeley area, where 146 growers used this combination. There were 34 operators in the Greeley region with crews of one man and three horses. A few men in each of these areas used odd crews. It will be seen that the 1–4 crew was employed on more farms than any other, indicating that leveling is heavy work, demanding a strong team. Under average conditions an ordinary crew will level from 10 to 13 acres in a 10-hour day.

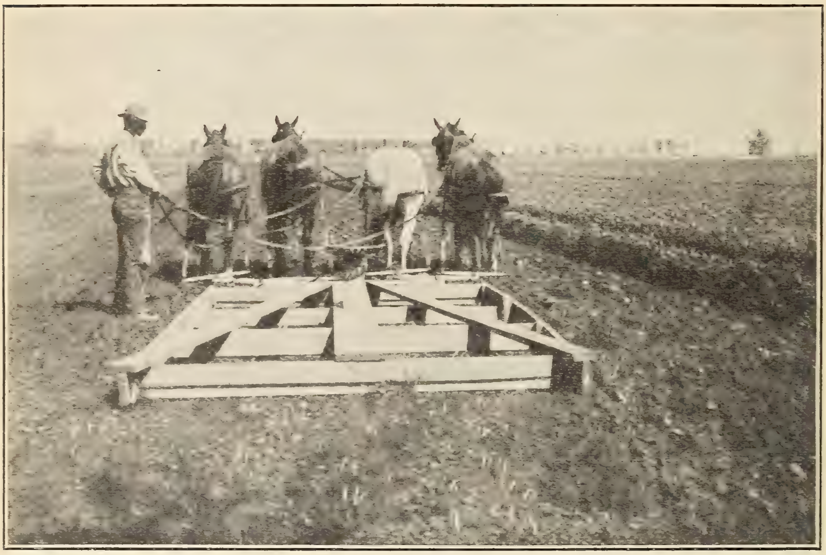


FIG. 7.—Leveling subsequent to plowing. This operation leaves the surface of the field in a smooth condition, and a uniform distribution of water is thereby made possible.

HARROWING.

Ninety-nine per cent of the growers included in this study used the spike-tooth harrow. The spike tooth not only has a pulverizing action on the soil, but it also has a slight leveling effect. On many farms it is customary to plow and harrow alternately from the beginning of the work until the entire field has been completed, harrowing "up to the plow" each night. Afterwards the beet land may be harrowed two, three, or more times at intervals of a week or 10 days. The harrowing season extended from March to May. The harrows used varied in width from 9 to 16 feet (fig. 8).

TABLE XI.—*Spike-tooth harrowing data for three Colorado districts.*

District.	Year.	Number of farms.	Acres harrowed per farm.	Number times harrowed.	Crew.		Hours per acre.		Total cost per acre.
					Man.	Horse.	Man.	Horse.	
Rocky Ford	1914–15	109	22.93	3.52	1	3.54	2.74	9.7	$1.46
Fort Morgan	1915	66	36.8	3.7	1	3.7	2.3	8.4	1.36
Greeley	1914–15	191	25.9	2.76	1	3.57	1.8	6.17	1.02

For all districts nearly all harrowing was done either by one man and four horses or one man and three horses. In the Rocky Ford district 58 per cent of the growers reporting on this operation used a 1–4 crew. At Fort Morgan the percentage for this crew was 71, while in the Greeley district it was 56. The 1–3 crew was used by 37 per cent at Rocky Ford, 30 per cent at Fort Morgan, and 39 per cent at Greeley. There were a few crews smaller and a few larger than these two. The Fort Morgan group did more harrowing than the Rocky Ford group and the average cost per acre was 10 cents lower in the former in 1915 than in the latter in 1914 and 1915. Greeley farmers had the lowest cost per acre for spike-tooth harrowing, but went over the beet land fewer times than did the men of either of the other areas. A day's work with the spike-tooth harrow with an average crew varied from 12.8 to 15 acres.

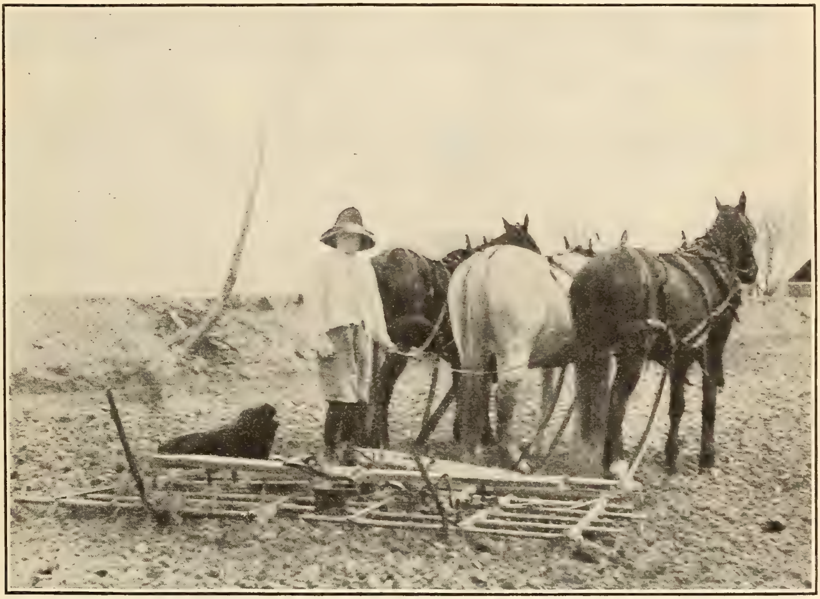


FIG. 8.—Harrowing with the spike tooth is one of the common operations in fitting the land for sugar beets.

SPRING-TOOTH HARROWING.

The spring-tooth harrow was operated on relatively few farms in the Rocky Ford and Fort Morgan districts, but enough growers at Greeley used this implement to afford reliable data. The spring-tooth is an excellent implement with which to loosen up fall-plowed land. Land plowed in early spring, which has been partially worked and has been packed with a few heavy rains, can also be brought into proper condition with a spring tooth. Inasmuch as only a small amount of plowing is done here in the autumn, it is highly probable that the spring-tooth was operated for the latter purpose. According to these records the season for spring-tooth harrowing extended from March to May. The average implement was 6 feet in width (Table XII).

TABLE XII.—*Spring-tooth harrowing data for three Colorado districts.*

District.	Year.	Number of farms.	Acres harrowed per farm.	Number times harrowed.	Crew.		Hours per acre.		Total cost per acre.
					Man.	Horse.	Man.	Horse.	
Rocky Ford	1914–15	5	13.7	2	1	3.4	3.42	11.4	$1.76
Fort Morgan	1915	10	17.0	1.8	1	4.2	2.3	9.8	1.52
Greeley	1914–15	62	21.05	1.56	1	4.0	1.77	7.0	1.11

On the Rocky Ford and Fort Morgan farms the beet land was spring-tooth harrowed approximately twice. Greeley farmers averaged one and one-half times. In the latter region 54 growers used a crew of one man and four horses. It will be observed that the cost per acre for spring-tooth harrowing was slightly more than the cost for similar work with the spike-tooth. Since the number of farms reporting from the Rocky Ford and Fort Morgan areas is small, it would be unfair to make a direct comparison with the Greeley group where the larger number obtains. Under average conditions 8 acres appears to be about the usual area covered per day with the spring-tooth.

ROLLING.

The roller not only serves a useful purpose in reducing clods or lumps in a dry soil, but also is valuable in packing the loose surface soil and in restoring connection with the supply of moisture in the subsoil. Only 17 per cent of the growers did rolling in the preparation of the seed bed. The majority of these were found in the Greeley district. At times the roller may be serviceable in producing a smooth surface for the drill.

The corrugated roller was used principally by Greeley growers. This implement varied in width from 8 to 9 feet and was operated on 29 Greeley farms by crews of one man and two horses, and on 16 farms by crews of one man and four horses. One man used a 1–3 crew. From 11 to 16 acres constituted a day's work with a roller (Table XIII).

TABLE XIII.—*Rolling data for three Colorado districts.*

District.	Year.	Number of of farms.	Acres rolled per farm.	Number of times rolled.	Crew.		Hours per acre.		Total cost per acre.
					Man.	Horse.	Man.	Horse.	
Rocky Ford	1914–15	14	24.2	1.46	1	2.92	1.26	3.7	$0.60
Fort Morgan	1915	2	10.0	1.00	1	2.00	.60	1.3	.26
Greeley	1914–15	46	24.05	1.10	1	2.70	.77	2.15	.39

CLEANING DITCHES.

Cleaning the laterals that connect the fields on the farm with the main canal is usually considered a special task, otherwise this work might be included under irrigation. During the irrigation season silt is deposited in the main laterals as well as in the distributing ditches. Dust and dead weeds may accumulate in the distributing canals during the winter months. Frequently also, weeds make such vigorous growth in the ditches that cutting them with a scythe and clearing them away becomes necessary. In order, therefore, to insure rapid delivery of water when the crop requires it, some work must be devoted to cleaning ditches prior to the first run in the canal. On many farms the cleaning is done with man and horse labor, while in some cases man labor only is expended.

Fifty-four per cent of all farms reporting on the field operations did the cleaning by hand (Table XIV). For the majority of the farms in this group cleaning was done once during the season, although a few men cleaned twice. Consequently, the averages which are given for the respective districts indicate slightly more than once over. This operation began early in the spring and extended almost to the end of the irrigation season. The greater part of the cleaning was done during the month of May or early in June. There were special instances where it was expedient to do some cleaning throughout the summer months. Rocky Ford growers put much more time on the cleaning than was expended at Greeley or Fort Morgan. The highest acre cost was reported from the former area. Considerable variation was found in the number of acres cleaned per day. The average area covered per day for the Rocky Ford area was 5.1 acres, for Greeley 9 acres, and for Fort Morgan 12 acres (fig. 9).

TABLE XIV.—*Cleaning data for three Colorado districts (work done by hand).*

District.	Year.	Number of farms.	Acres cleaned per farm.	Number times cleaned.	Number of men.	Hours per acre.	Cost per acre.
Rocky Ford	1914–15	52	22.75	1.21	1	2.37	$0.43
Fort Morgan	1915	42	37.97	1.09	1	.91	.17
Greeley	1914–15	107	25.6	1.06	1	1.12	.23

TABLE XV.—*Cleaning data for three Colorado districts (work done by man and horse labor).*

District.	Year.	Number of farms.	Acres cleaned per farm.	Number times cleaned.	Crew.		Hours per acre.		Total cost per acre.
					Man.	Horse.	Man.	Horse.	
Rocky Ford	1914–15	55	25.2	1.44	1.6	2.49	1.73	2.90	$0.60
Fort Morgan	1915	56	37.53	1.44	1.62	3.12	.94	2.07	.41
Greeley	1914–15	53	28.9	1.04	1.34	3.24	.3	.63	.13

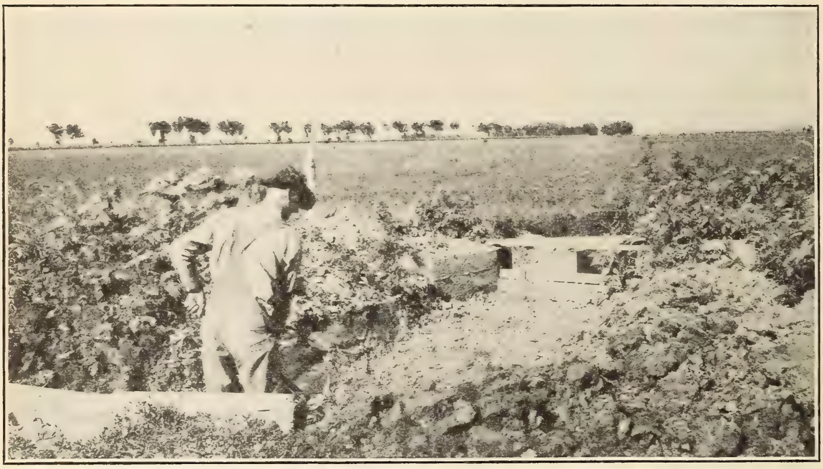


FIG. 9.—Removing silt from an irrigation ditch. In order to insure rapid delivery of water when the crop requires it, some work must be devoted to cleaning ditches a few weeks prior to the first run in the canal.

On farms where the canal and distributing laterals are accessible to horses, silt and other débris that have been deposited can be loosened with a plow and the accumulated material can be removed with a home-made V ditcher (fig. 10). By using horses much more work usually can be done within a limited period than by hand, though it does not necessarily follow that the work can be accomplished at a lower cost. Where equal amounts of work are involved, the combined crew will undoubtedly have the advantage. The three districts were represented by approximately equal numbers of men who did cleaning with a combined crew. Cleaning was done practically 1½ times at Rocky Ford and Fort Morgan. Greeley growers averaged slightly more than once over. In this practice there was also a marked difference in the area ditched per day—from 8.3 acres in the Rocky Ford district to 34.6 in the Greeley area. Manifestly, the cost per acre for each district is directly related to the amount of work done per day. It should be noted that during certain seasons much more ditch-cleaning work is necessary in some districts than in others. Out of 164 growers reporting, 44 used crews made up of one man and two horses, 40 employed crews of two men and three horses, 22 indicated the use of one man and three horses, and 19 had crews of two men and two horses. The records do not indicate that the crew size increased or decreased the cost per acre for cleaning. Where high costs are shown it simply means that more work was necessary there to place the ditches in good condition. In comparing hand labor with hand and horse labor in ditch cleaning, it must not be assumed that the lower cost for the former justifies a recommendation that the work always be done by hand. It is probably true that effective work with a plow and V ditcher one season will enable the grower to handle the situation by hand the succeeding season.

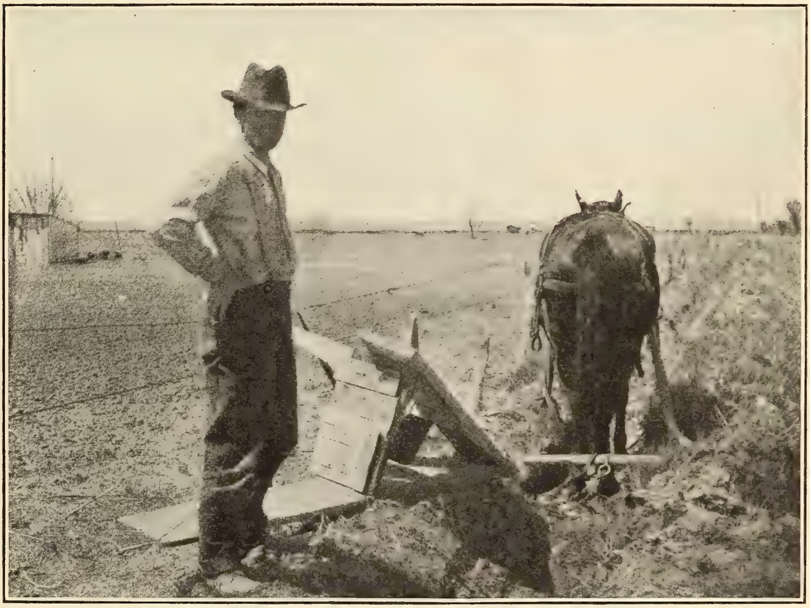


FIG. 10.—Removing silt and other débris with a homemade V ditcher. It will be seen that the deposit of silt was first loosened with a plow.

PLANTING.

Planting practice was uniform throughout the three districts. As a matter of fact this operation does not vary much, no matter what the conditions. The four-row beet drill is an implement common to all beet-growing areas of this country, and it is everywhere used in about the same way. To insure good work with the planter, the surface of the field should be smooth and free from any large clods, and the soil ought to be firm enough to enable the operator to manipulate the drill readily, otherwise the drill wheels will sink and the seed can not be planted at an even depth. If these essentials are obtained, straight rows can be made, which are not only pleasing to the eye and give the owner a sense of gratification as the season advances, but also make it easier for the driver to operate the cultivator, especially while the plants are small. Thus the stand is not impaired by having some of the beets cut out with the cultivator knives. The rows averaged 20 inches apart in the Fort Morgan district, approximately the same in the Greeley district, and at Rocky Ford 19 inches. Some of the Greeley farmers made a practice of planting wide and narrow rows in pairs. The usual distance apart for these pairs was 16 and 24 inches. Such an arrangement not only provided a set of wide rows in which to drive the horses when cultivating, but also furnished more space for irrigation ditches (fig. 11).

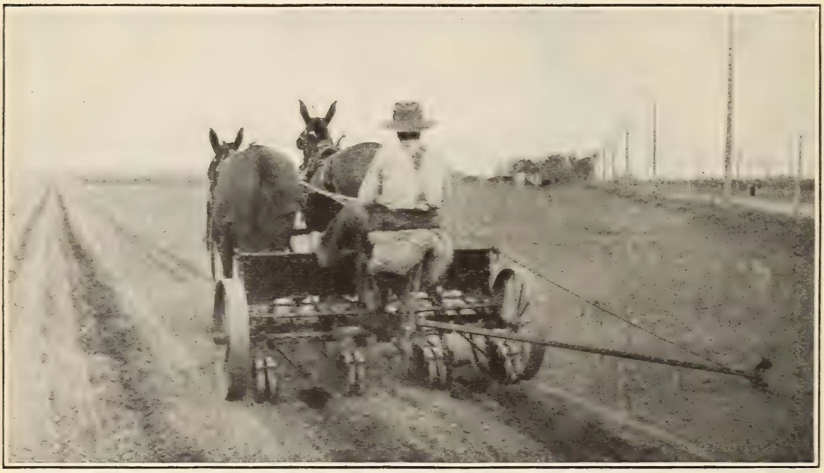


FIG. 11.—Planting beet seed with a four-row beet drill. The marker to the right makes a line that serves as a guide for the driver. Furrowing-out shovels are also attached to this beet drill.

The dates of planting in the Rocky Ford district varied from April 1 to June 15, at Fort Morgan from May 10 to June 22, and at Greeley from April 1 to June 20. These dates included the very early and very late planting. There was a little replanting in each district, which undoubtedly had a tendency to carry the latest date of planting somewhat beyond the customary limits. Under normal conditions planting in all of these areas is quite general during the latter part of April and early in May (Table XVI).

TABLE XVI.—*Planting data for three Colorado districts.*

District.	Year.	Number of farms.	Acres planted per farm.	Crew.		Hours per acre.		Total cost per acre.
				Man.	Horse.	Man.	Horse.	
Rocky Ford	1914–15	109	23.02	1	2	1.14	2.30	$0.44
Fort Morgan	1915	66	37.2	1	2	1.03	2.09	.43
Greeley	1914–15	195	25.66	1	2	1.06	2.13	.43

It has been customary in these areas to use approximately 20 pounds of seed per acre. Recently, owing to the scarcity of beet seed the amount used has been reduced considerably. It has been found that a seeding of 10 to 12 pounds per acre gives very satisfactory results, provided soil conditions are right. Planting was done universally by one man and two horses. Growers in these three districts averaged nine to ten acres per day. The cost for planting in 1914 and 1915 was practically identical for the three districts.

ROLLING BEETS.

The practice of rolling has been discussed in part in connection with the preparation of the seed bed. However, the practice of rolling beets was considered important enough to be considered separately. This operation is performed after the seed had been planted and many of the young plants have begun to appear. Light showers occur frequently at this season of the year and the soil has a tendency to become baked. When this condition is pronounced, the young plants may be prevented from coming through and a poor stand will be the result. Some growers make a practice of harrowing in order to restore the surface mulch, but if the field is rolled, the crust can be broken and the beet plants will not be checked in their growth. Rolling at this period may also put the soil in better condition for bunching and thinning. Furthermore, rolling promotes capillary action, which is very essential to rapid growth. In these three districts the rolling after planting was done almost exclusively with a corrugated roller (fig. 12).

On some farms this work was done before thinning, on others after thinning and blocking. Rolling packs the soil about the beet and facilitates recovery of the plant after being disturbed with the hoe or by hand. Moreover, bunching with a hoe creates a small ridge between the rows, and if this is made smooth with a roller, the cultivator can be guided more readily. The Fort Morgan and Greeley growers averaged a little more than once over; the Rocky Ford growers one and one-fifth times over. The rolling was done almost entirely with crews of one man and two horses. The cost for this operation in 1914 and 1915 was somewhat lower than that for rolling in seed bed preparation (Table XVII).

TABLE XVII.—*Rolling beet data for three Colorado areas.*

District.	Year.	Number of farms.	Acres rolled per farm.	Number times rolled.	Crew.		Hours per acre.		Total cost per acre.
					Man.	Horse.	Man.	Horse.	
Rocky Ford	1914–15	74	22.4	1.21	1	2.1	0.97	2.1	$0.38
Fort Morgan	1915	20	16.9	1.05	1	2.1	.75	1.56	.31
Greeley	1914–15	96	24.28	1.18	1	2.26	1.01	2.2	.43

CONTRACT LABOR.

The hand work on sugar beets includes blocking and thinning, two regular hoeings, occasionally a third hoeing with some weeding, and pulling and topping. These operations, taken collectively, are known as contract labor. The blocking is done with a hoe. The beet seed is drilled in a continuous row and after germination takes place more plants are usually present than are necessary to insure a good stand. By blocking or chopping out the surplus plants with a hoe, small bunches containing three or more beets are left 10 to 12 inches apart in the row. The thinning of the bunches which follows is done by hand. In addition to blocking, the operator cuts off any weeds left by the cultivator. The manner of performing these operations is described in the following rules and regulations governing hand work, from sample contract, 1915:

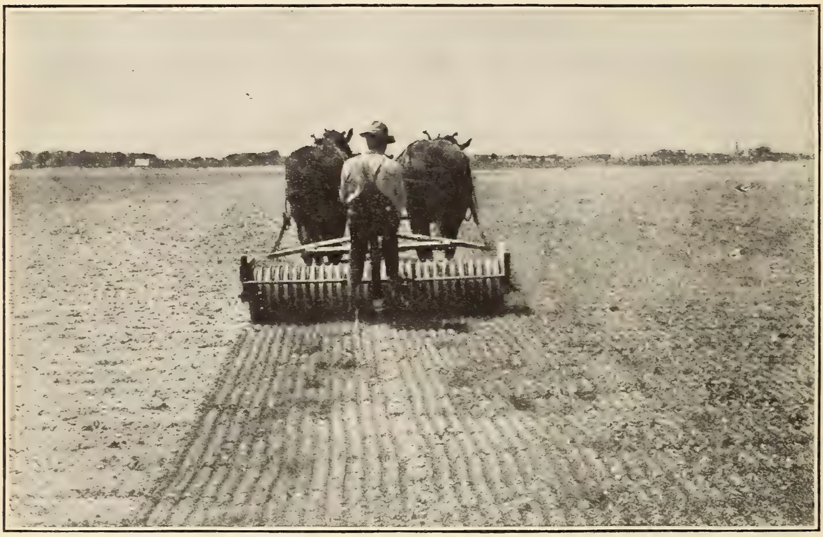


FIG. 12.—Rolling sugar beets. Rolling not only breaks any crust that may exist, but it also firms the soil and thereby facilitates blocking and thinning.

Bunching and thinning.—This work must be commenced by the contractor just as soon as the beets show four leaves and the grower has them cultivated, and must be completed as rapidly as possible in the following manner, to wit: Beets to be thinned from 7 to 10 inches apart, leaving only one plant in each place; no double beets shall be left. This work must be done so that the land will be entirely free from weeds.

Second hoeing.—This work must be commenced by the contractor as soon as the thinning is completed and the grower has finished the second cultivation by hoeing a little deeper than the first hoeing, killing and removing all weeds, and removing any double plants that may have been overlooked in the thinning. The grower must keep the crop cultivated so that at least 10 inches of the center of the row remains clear of all weeds and foul growth up to the time of the third hoeing.

Third hoeing.—A third hoeing must be given the beets by the contractor, and in addition to such third hoeing any and all further hoeing necessary to keep the beets free from weeds until harvest of the beets is commenced must be done by the contractor, and in the event of the beets having grown so large that a third or further hoeing would injure them, then all weeds that grow up to the time of the commencement of harvest must be removed by hand, as the beets must be kept free from weeds at all times until harvested.

Blocking and thinning.—For the early plantings, the blocking and thinning may begin in the latter part of April. Under normal conditions the contract labor should be well under way by the middle of May. For the late plantings, or fields that may require replanting, the time for blocking and thinning may extend to the middle of June. This work was done in the Rocky Ford district almost entirely on a contract basis. There were but two men in this region who did their own hand work. The blocking and thinning on these farms required 30.8 hours per acre and cost $5.54. There were 23 growers at Fort Morgan who handled either a part or all of their own blocking and thinning, while the Greeley list afforded only 28 records on this operation. The Fort Morgan growers spent 28.6 hours per acre in blocking and thinning, involving a cost of $5.44 per acre, in 1915, while the Greeley growers had an average labor requirement of 25.4 hours per acre, with a cost of $4.83 per acre, in

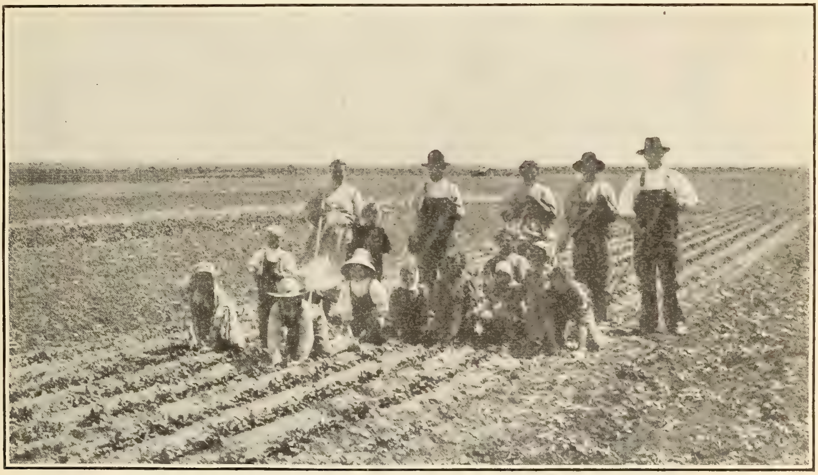


FIG. 13.—Bunching and thinning.

1914 and 1915. The usual contract price for the blocking and thinning in northern Colorado during 1914–15 was $6 per acre (fig. 13). It will be seen that the estimated cost for those farms where the operator did this work himself was somewhat lower than the contract price. This was also true of hoeing.

Hoeing.—There were 28 farms in the Rocky Ford section, 23 at Fort Morgan, and 32 at Greeley that reported on hoeing practice. Practically two hoeings were given in addition to the blocking. It required 10.2 man-hours per acre to do the hoeing on the Rocky Ford farms in 1914 and 1915, and the cost was $1.84 per acre. The Fort Morgan growers spent 12.2 hours per acre in 1915, involving a cost of $2.33, while at Greeley, in 1914 and 1915, 10.9 hours per acre were consumed in doing the hoeing, and the cost was $2.07.

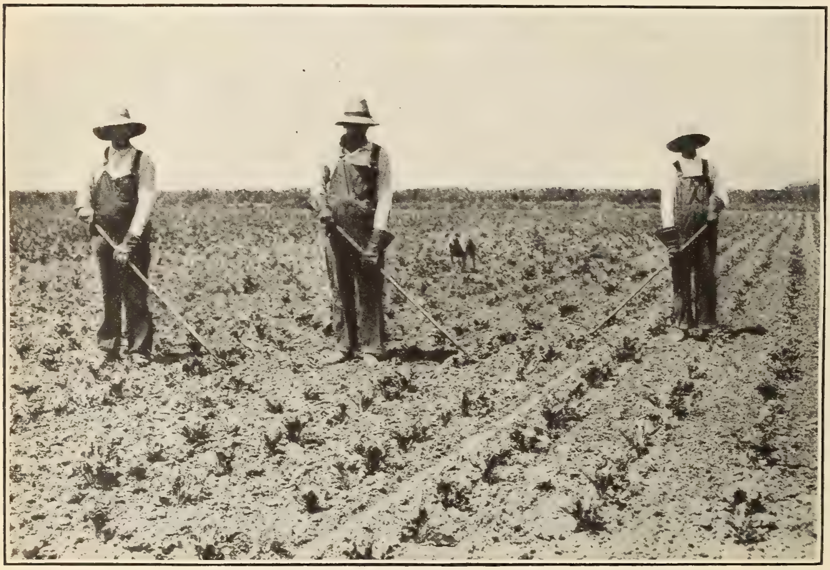


FIG. 14.—Hoeing beets. This work must be commenced by the contractor as soon as the thinning is completed and the grower has finished the second cultivation.

The contract acre rate for the second and third hoeings at Greeley and Fort Morgan was $2 and $1, respectively. It will be observed that the estimated cost for hoeing was much less than the contract labor rate. The time for hoeing extended from May to August (fig. 14).

CULTIVATION.

As soon as the plants show four leaves, before blocking and thinning, the first cultivation is given (Table XVIII). The cultivator is equipped with L-shaped knives for cutting a small amount of earth away from the row (fig. 15). A small duck foot is used to stir the

Table XVIII.—*Cultivating data for three Colorado districts.*

District.	Year.	Number of farms.	Acres cultivated per farm.	Number times cultivated.	Crew.		Hours per acre.		Total cost per acre.
					Man.	Horse.	Man.	Horse.	
Rocky Ford	1914–15	110	22.90	5.54	1	1.96	6.54	12.8	$2.46
Fort Morgan	1915	66	36.9	5.09	1	2.00	4.94	9.89	2.03
Greeley	1914–15	195	26.09	4.31	1	2.00	4.85	9.35	1.95

soil between the rows. All of the small weeds outside of the row are cut off at the first cultivation. The object usually is to make a mulch of granular soil, which checks the upward movement of moisture, but does not blow readily. On some farms the disk cultivator is used for the preliminary work. The dates of cultivation varied for the majority of operators from May to July. On some farms work on late beets ran into August. It is customary in these three areas to give from three to five cultivations per season. The Greeley growers averaged slightly more than four times in cultivating the beet crop in 1914–15 (fig. 16).

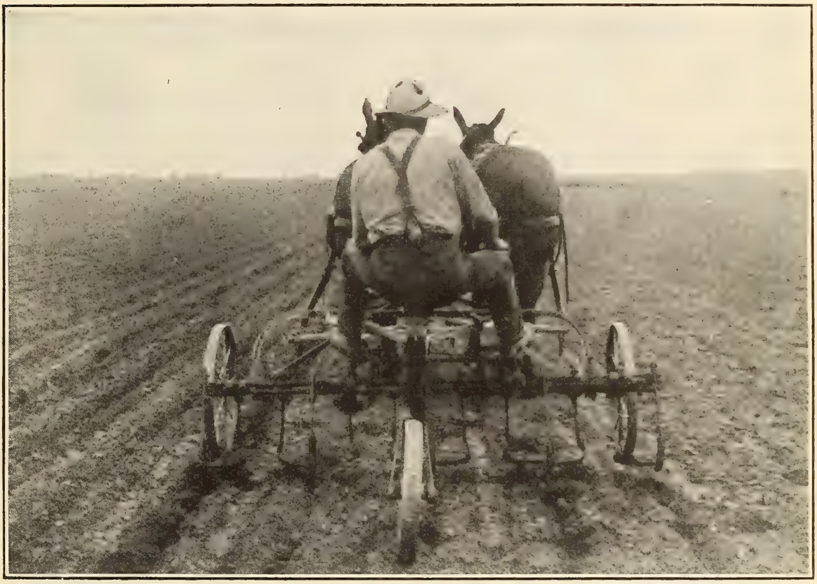


Fig. 15.—Giving the first cultivation. This work is done as soon as the plants show four leaves.

All of the farmers reported on this operation. The common-field crew required in handling the ordinary 4-row cultivator consisted of one man and two horses. There were a few operators who cultivated with a one-man-one-horse crew on small tracts. The cost per acre was approximately $2 for the Fort Morgan and Greeley areas, while in the Rocky Ford region it was about $2.50. A day's work with a cultivator varied on the average from 8.4 acres in the Rocky Ford district to 8.8 acres in the Greeley district.

TABLE XIX.—*Furrowing data for three Colorado districts.*

District.	Year.	Number of farms.	Acres furrowed per farm.	Number times furrowed.	Crew.		Hours per acre.		Total cost per acre.
					Man.	Horse.	Man.	Horse.	
Rocky Ford	1914–15	66	20.73	2.75	1	1.93	2.93	5.80	$1.11
Fort Morgan	1915	66	36.9	1.08	1	2.00	.99	2.08	.42
Greeley	1914–15	195	25.76	1.42	1	1.98	1.51	2.94	.61

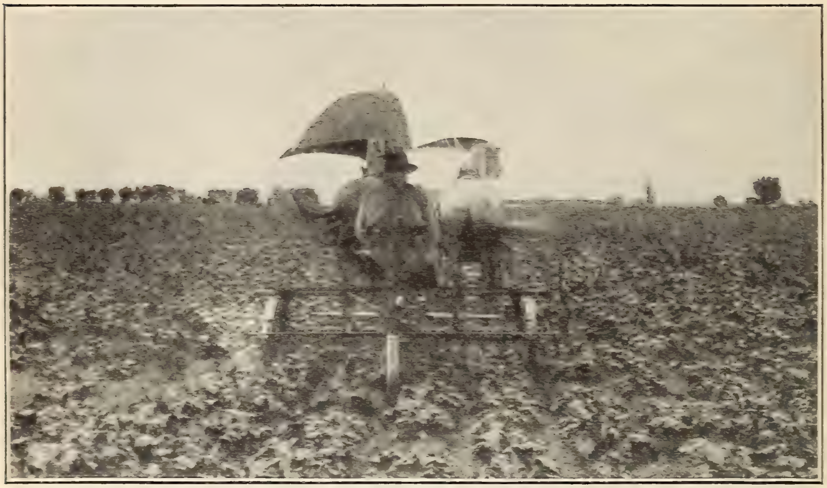


FIG. 16.—Cultivating sugar beets.

Eighty-eight per cent of the growers reported on furrowing, or preparation for irrigation. In the Rocky Ford district the operators furrowed approximately three times, one furrowing coming early, immediately after planting. There was an intermediate furrowing and a third after cultivation had ceased. Cultivating the land after an irrigation necessitates a repetition of the furrowing. In northern Colorado furrowing was done almost entirely after the last cultivation. This operation required, in general, a crew of one man and two horses. The variation in cost in 1914 and 1915 shown in Table XIX is mainly due to variation in the number of times the fields were furrowed. A day's work furrowing ranged from 9.4 acres to 10 acres as averages for these groups.

SLEDDING.

Sledding is an operation which was common in the Arkansas Valley only. The operation was performed with a homemade sled consisting of two small logs held together by crosspieces. These logs are just far enough apart to span a pair of furrows, each log, when the sled is running, crushing any clods or lumps that may be in its furrow and leaving the surface smooth (fig. 17). Thus, when the water is turned into the furrow it passes rapidly from one end to the other and a uniform distribution is secured. Sixty-eight growers reported on sledding in 1914 and 1915. The fields were gone over twice during the season, once for the first irrigation and once later.

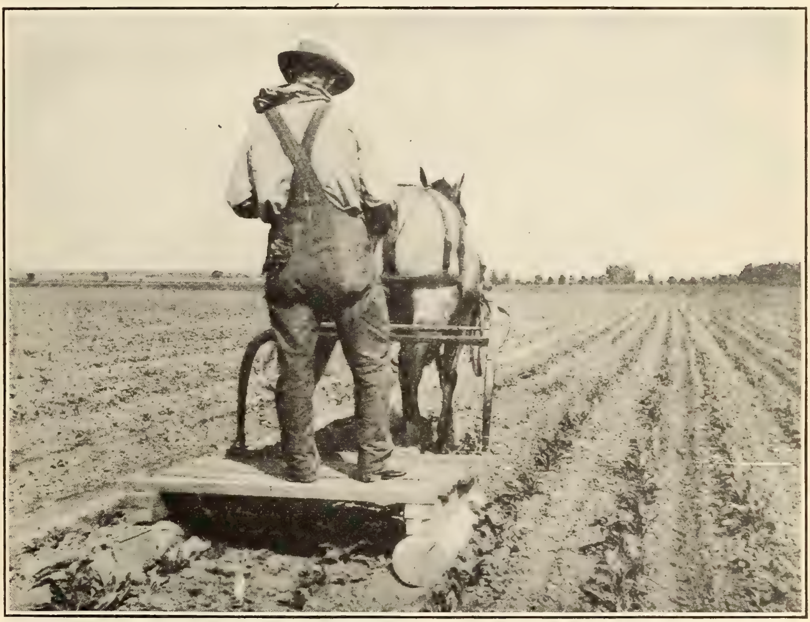


FIG. 17.—Sledding out prior to irrigating the young sugar beets. This insures a more rapid movement of the water and assists in obtaining a more even distribution of water in the soil.

The crew on many of these farms consisted of one man and one horse. A few growers used one man and two horses. Sledding required 2.2 man-hours and 3.5 horse-hours per acre, and cost 75 cents per acre. These growers averaged 9.3 acres per day sledding. In the other districts small logs sometimes were attached to the shovels on the cultivator and the sledding was done simultaneously with the furrowing out.

IRRIGATION.

It has been pointed out that there is a slight difference in climatic conditions between the Arkansas Valley and the northern and eastern areas of the State. It is customary to irrigate early in the season in the Arkansas Valley (fig. 18). This means turning the water into the field immediately after planting. On some farms, however, it is the practice to irrigate the land in the autumn (fig. 19).

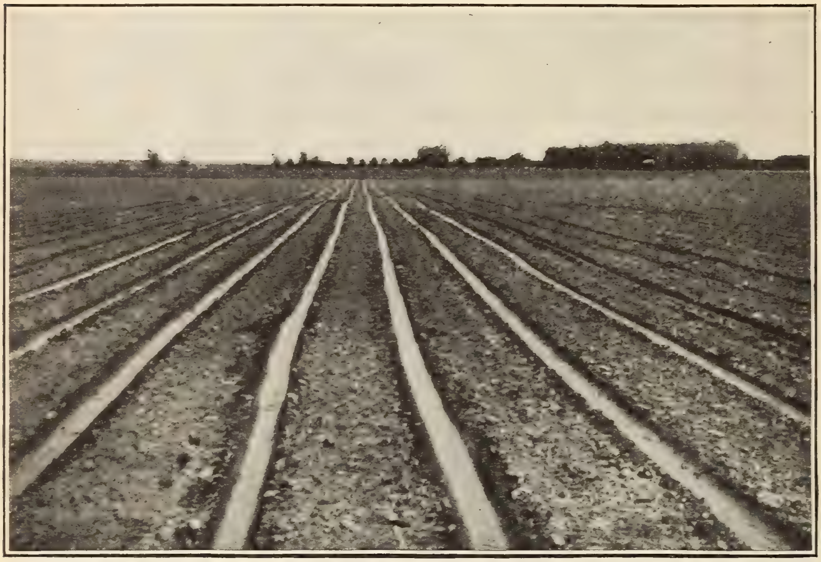


FIG. 18.—Showing irrigation water in rows that were made smooth and even with the aid of a sled.

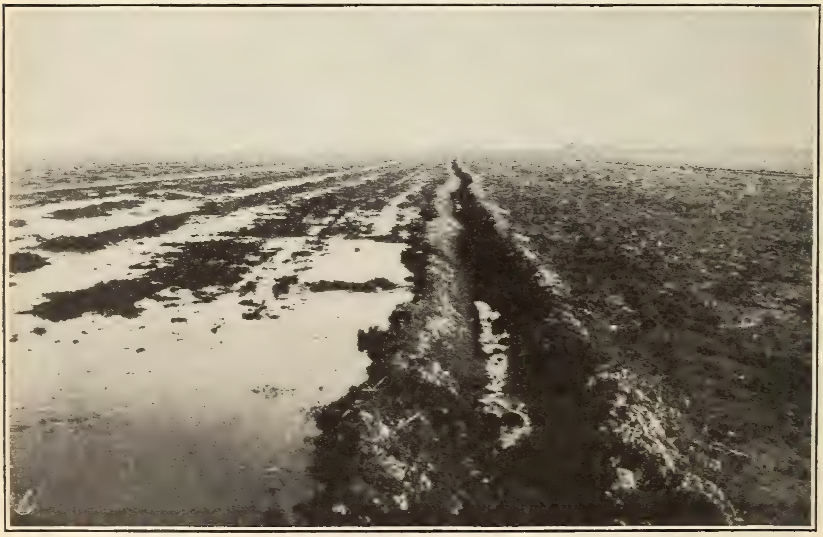


FIG. 19.—Irrigating sugar-beet land in the autumn. The moistened soil responds more readily to the action of frost than dry soil.

The available supply of water in this region depends largely upon the water stored in reservoirs for irrigating sugar beets. Ordinarily the rivers do not carry much water that can be utilized for irrigation after July 1. From 12 to 20 inches of water is used upon the beet crop.

TABLE XX.—*Irrigation data for three Colorado districts.*

District.	Year.	Number of farms.	Acres irrigated per farm.	Number times irrigated.	Number of men.	Man hours per acre.	Cost per acre.
Rocky Ford	1914–15	110	22.9	3.58	1	8.7	$1.57
Fort Morgan	1915	66	36.7	2.49	1	7.79	1.48
Greeley	1914–15	192	25.79	2.96	1	8.5	1.62

Practice records on irrigation were obtained from 368 growers (Table XX). In the Arkansas Valley the time for irrigation varied from April 15 to September 10, while in northern Colorado the initial irrigation was given July 1 and the final work was completed September 30. Greeley growers averaged three irrigations for the season, Fort Morgan operators two and one-half, and the Rocky Ford area three and one-half. There was little variation in the labor requirements or the final costs for this operation in 1914 and 1915. A day's work of eight hours amounted to 3.5 acres in the Greeley area and 4.1 acres in the Rocky Ford district. This would mean irrigating from 10 to 12 acres in 24 hours. Water is usually run continuously day and night and is given more or less attention throughout the run (fig. 20).

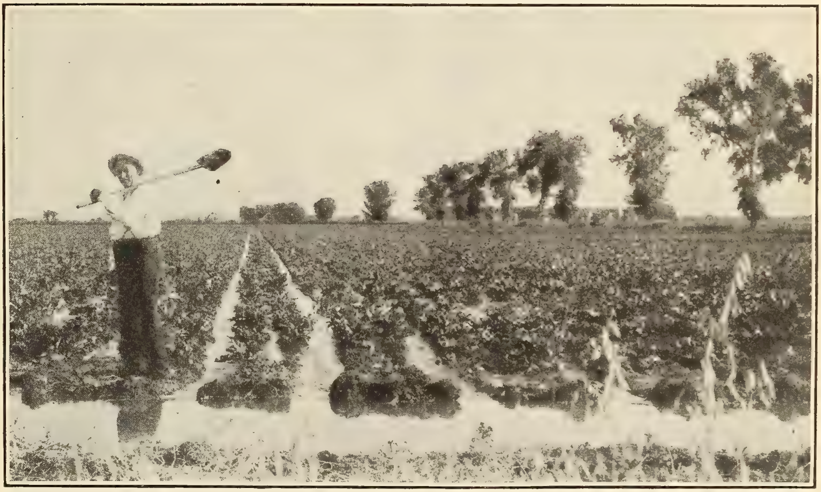


FIG. 20.—Irrigating sugar beets in the Greeley area. The method of distributing water is shown in this illustration.

LIFTING, OR PLOWING OUT.

Lifting, topping, and hauling are three operations which go hand in hand. Lifting involves loosening the beets in the soil so that they can be taken out readily by hand and thrown into piles. Two types of pullers or lifters were used in these districts. One, known as the "crotch" or "straddle puller," has two shafts, with special points which pass on either side of the row. The other type is known as the "side puller" and has only one shaft with a single point. In both cases only one row is pulled at a time (fig. 21). Lifting or pulling coincides with the harvesting dates (Table XXI). During the two years of this investigation (1914 and 1915) harvesting in the Rocky Ford district ran from September 1 to December 15, at Fort Morgan from September 20 to November 20, and at Greeley from August 25 to November 26. Occasionally unfavorable weather occurs during the harvest period and this has a tendency to delay or prevent harvesting.

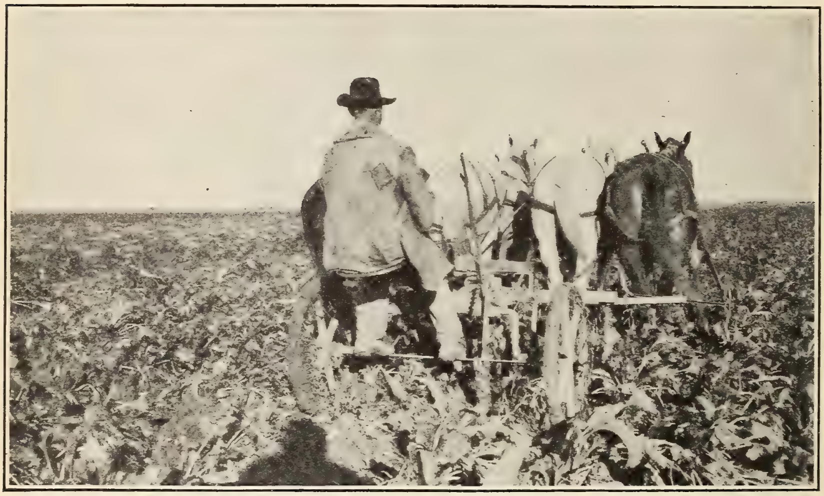


FIG. 21.—Plowing out sugar beets in the Fort Morgan district. On 46 farms the crew for this operation consisted of one man and four horses.

TABLE XXI.—*Lifting data for three Colorado districts.*

District.	Year.	Number of farms.	Acres lifted per farm.	Crew.		Hours per acre.		Total cost per acre.
				Man.	Horse.	Man.	Horse.	
Rocky Ford	1914–15	106	22.95	1	3.42	5.54	18.43	$2.84
Fort Morgan	1915	66	36.7	1	3.00	4.09	12.10	2.11
Greeley	1914–15	195	25.76	1	3.05	5.12	15.54	2.68

There was considerable difference in each area in the number of horses used to do the lifting. In the Rocky Ford area on 52 farms a crew of one man and three horses did the plowing out; on 46 farms one man and four horses; and on 6 farms one man and two horses. In the Fort Morgan district the farms reporting were about equally divided among these three crew sizes. Greeley growers favored the 1–3 crew, 129 farmers reporting this size; 38, the 1–4 crew; and 28 the 1–2 crew. A few crews of odd sizes were used.

The number of horses used in plowing out beets is determined largely by the type of soil, and by the climatic conditions at the time of harvest. A day's work with the lifter varied from 1.8 to 2.2 acres.

TOPPING.

Fifteen per cent of the farmers reporting did a part of the topping themselves and gave estimates on this operation. The work was done from the latter part of August to the middle or latter part of December (fig. 22). The estimated labor costs for topping in 1914 and 1915 were much lower for all districts than the rates charged under the contract method. In the Rocky Ford district 25.8 man hours were expended in topping an average yield of 11.2 tons per acre, in the Fort Morgan area 30.4 hours for a 13.4-ton yield, and at Greeley 25.1 hours for a yield of 14.2 tons per acre. The cost for these few farms varied from $4.64 to $5.78 per acre. The contract price for pulling and topping in the Greeley and Fort Morgan districts was $9 per acre. The prevailing price for man labor is much higher during the harvest season than at other seasons of the year.

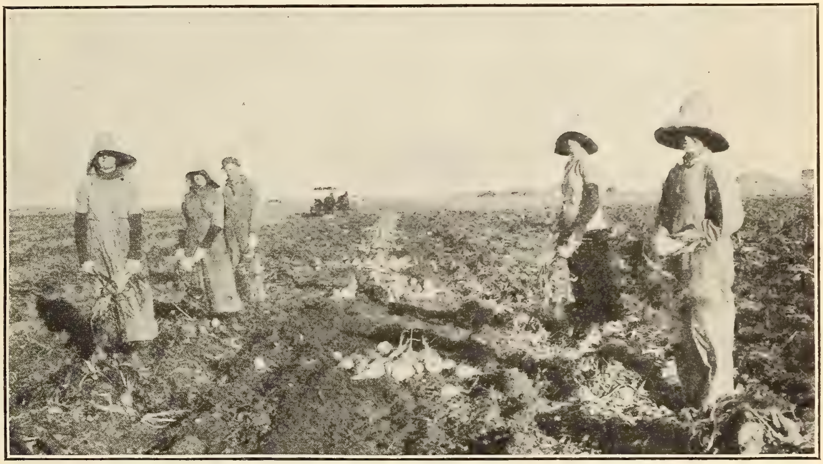


FIG. 22.—Topping sugar beets. It is stipulated that the tops shall be cut off squarely just below the crown at the base of the bottom leaf.

Taking all items into consideration, the hand labor received $18 per acre plus an additional 25 cents per ton for each ton in excess of an average yield of 12 tons per acre.

Following are the rules and regulations governing pulling and topping in the areas covered in this study:

> The work must be done just as soon as the grower receives orders from the company to dig his beets. The plowing out shall be done by the grower. The beets

must be pulled by the contractor, and cleaned of adhering dirt by knocking the beets together or otherwise as pulled, and throwing them into piles. The ground on which the beets are to be piled must be cleaned off and leveled down by the contractor, so that the grower may fork the beets into the wagon free from dirt, rocks, leaves, or other trash.

The beets shall be topped by the contractor in the following manner, to wit, by cutting off the tops squarely just below the crown at the base of the bottom leaf. Knives shall not be used for lifting beets, but hooks may be used, provided they are properly driven into the top of the crown of the beet only.

All tools for hand work shall be furnished by the grower.

All cultivating, irrigating, plowing out, and loading shall be done by the grower, unless otherwise agreed upon.

All beets left in the field over night must be protected properly from frost by the contractor by covering the piles with beet tops, the tops to be removed by the grower before beets are loaded.

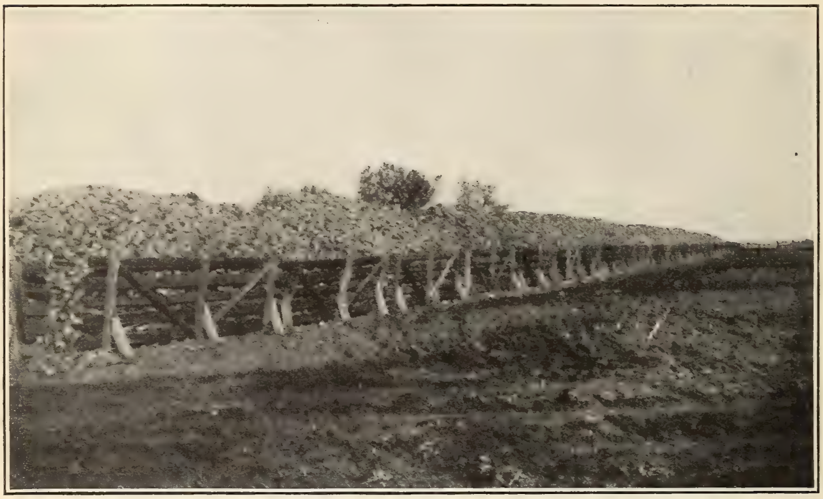


FIG. 23.—Sugar beets piled at a loading station. Surplus beets are sometimes thrown into large piles at the receiving stations, and these are then reloaded when the supply from the field is curtailed by bad weather or otherwise.

The grower reserves the right, in the event the hand work is not done properly or with sufficient rapidity by the contractor that the crop would thereby suffer, to engage additional help for doing the work as cheaply as practicable under existing conditions, and to deduct the expense of the same from this contract, it being agreed and understood, however, that in the event of any dispute arising between the grower and contractor as to the interpretation of the above rules, as to the manner in which the work is being done, or as to the necessity of additional help, the agricultural superintendent or field man of the company shall act as referee, and his decision shall be final and binding on both the contractor and grower.

PITTING SUGAR BEETS.

During the harvest season beets are sometimes taken out much more rapidly than they can be received by the sugar company. It is therefore the custom to put a portion of the crop in pits during this period. Pitting was found to be much more common in the

Arkansas Valley than in northern Colorado. In the latter district surplus beets were thrown in large piles at the receiving stations and loaded at times when the delivery from the growers was slack (fig. 23). In the Arkansas Valley when beets are held in the field they are placed in a cone-shaped pile and are covered with a small quantity of earth to prevent freezing. As soon as the beets have all been harvested and available supplies have been sliced, the growers are called upon to deliver their pitted beets. Inasmuch as this operation required extra labor, the sugar company paid an additional premium of 75 cents per ton over and above the regular market price.

Twenty-eight growers reported on pitting beets in the Rocky Ford district. These men cared for 6.6 acres per farm in this way. The average yield for this area was 13.2 tons per acre. Man labor only was involved, the cost per acre approximating $1.30 in 1914 and 1915. On some farms it is necessary to use horses to haul beets to the pit. There were three records reported from the Greeley area and a like number from the Fort Morgan district. Both man and horse labor entered into this work. The cost varied from $1.83 per acre at Greeley to $2.80 per acre at Fort Morgan.

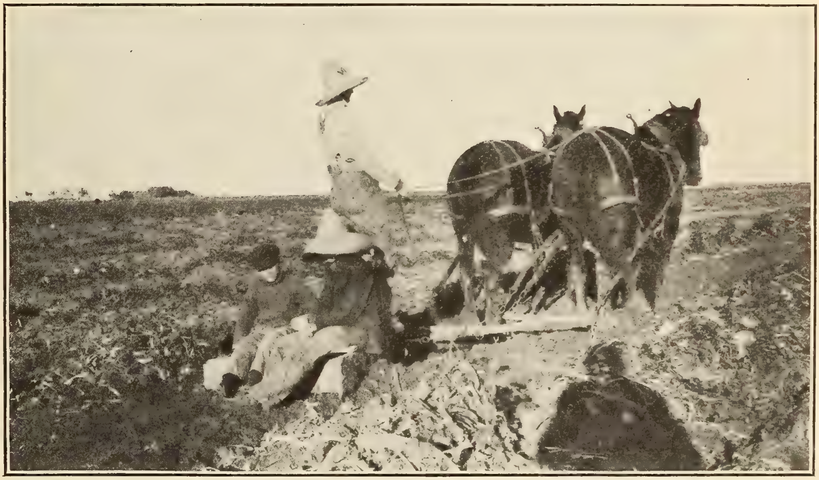


FIG. 24.—Leveling a strip of land upon which topped beets are to be piled. The contract requires the man who is engaged to do the hand labor to clean off and level the ground so that the beets may be thrown into the wagon free from dirt or trash. In this case the operator did a large part of the hand labor.

LEVELING FOR BEET PILES.

Within recent years a large number of farmers have adopted the practice of using a V leveler for the purpose of making a smooth strip of soil upon which to throw the beets. Where no leveling is done, small clods and beet tops will be taken up when the sugar beets are loaded on the wagon. Leveling removes a part of this trash. Only a few growers, however, reported on this operation. This work in a number of cases was included with the lifting of the crop, and on other farms the contract laborer was required to do this work with a garden rake as a part of his contract labor. The number of records obtained was not large enough to warrant any definite conclusions with reference to the time consumed or the cost per acre. A span of horses with a V-shaped leveler can prepare sufficient space for several rows of beets in a short time (fig. 24).

HAULING.

It has been pointed out that hauling is done at the same time as the lifting and topping. Ninety-six per cent of the growers included in this investigation gave information on hauling; the remainder of these growers hired hauling done by contract. Heavy wagons were used, equipped with strong, well-built beet boxes of special type (figs. 25 and 26). The loading was done with forks or by hand. Rain occasionally leaves the ground heavy and makes it necessary to use an extra team. In cases in which the crop was delivered directly to the cars at the loading station, no hand labor was required. The unloading at the beet dump was done mechanically (figs. 27 and 28).

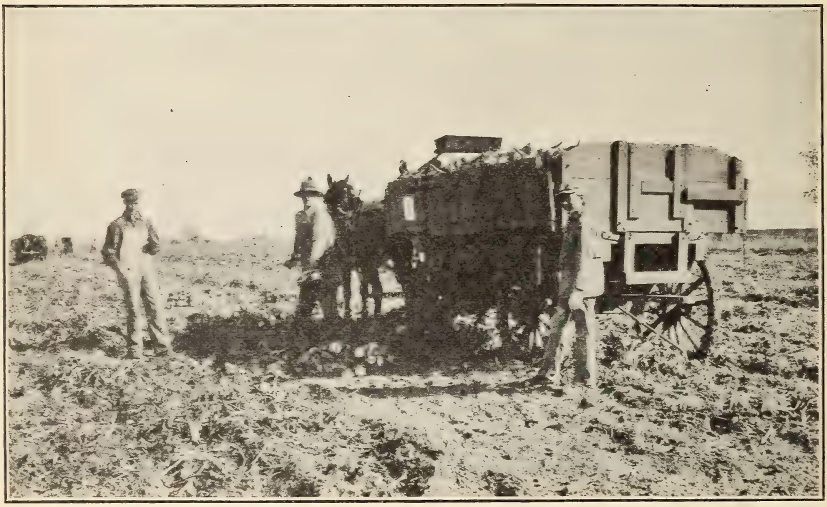


FIG. 25.—Loading sugar beets with fork from small piles in field.

In the Rocky Ford district 22 growers marketed the beets with a crew of one man and two horses, while 67 growers utilized a 1–4 crew. In the Fort Morgan area 43 operators used a crew consisting of one man and two horses, while 13 growers hauled with a crew of one man and four horses. The Greeley area, which furnished the largest number of records, had 126 growers who reported a crew of one man and two horses, 46 reporting one man and four horses, and 8 reporting one man and three horses. A few odd crews were reported. There was a variation in cost from $5.64 per acre, which was the average for the Fort Morgan list of growers in 1915, to $6.86 per acre for the Rocky Ford group in 1914 and 1915 (Table XXII).

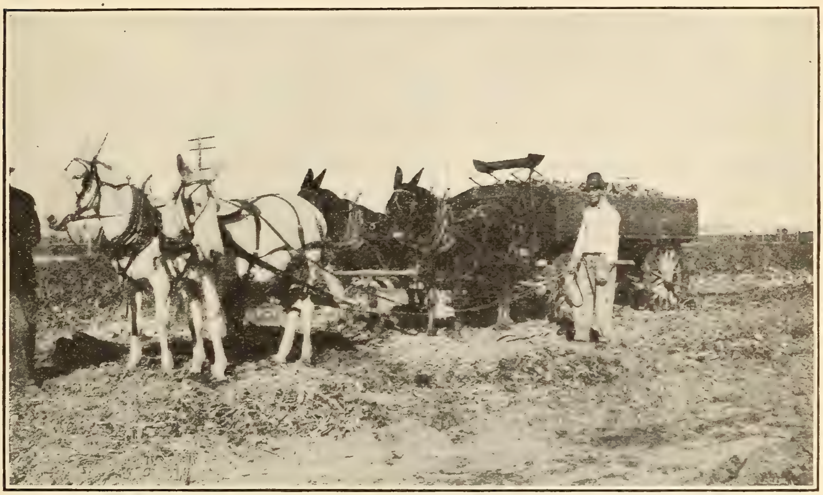


FIG. 26.—Hauling sugar beets from the field. When the soilis soft an extra team is used to assist in getting the load to a solid road.

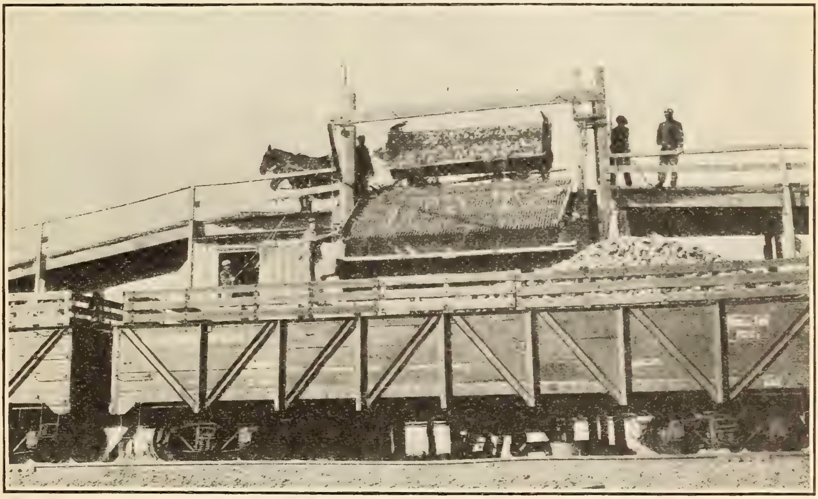


FIG. 27.—Unloading beets mechanically. This type of machine is known as the rocker dump.

TABLE XXII.—*Hauling data for three Colorado districts.*

District.	Year.	Number of farms.	Acres hauled per farm.	Tons hauled per acre.	Distance hauled.	Average crew.		Hours per acre.		Total cost per acre.
						Man.	Horse.	Man.	Horse.	
					Miles.					
Rocky Ford	1914–15	107	22.84	13.07	1.81	1.1	3.56	13.61	44.11	$6.86
Fort Morgan	1915	66	35.58	13.94	1.8	1.07	2.59	12.34	30.01	5.64
Greeley	1914–15	184	25.56	15.35	1.54	1.00	2.53	13.03	32.44	6.05

Distance of hauling and its relation to cost.—It is generally conceded that the distance from the loading station is an important factor in determining cost. The records for all districts were sorted upon the basis of distance, and the average cost per ton for the several groups was computed.

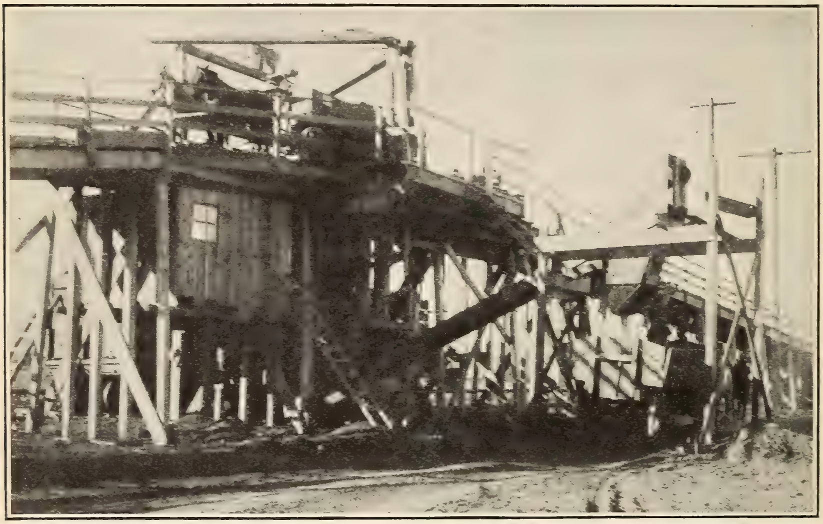


FIG. 28.—Showing device at loading station for removing the soil that sifts through the sieve as the beets pass from the wagon to the car.

TABLE XXIII.—*Relation of distance from loading station to cost of delivering the sugar beet (1914 and 1915).*

Distance (miles).	Average distance.	Number of records.	Average crew.		Average cost per ton.
			Man.	Horse.	
	Miles.				
1 or less	0.80	93	1	3.19	$0.40
1 to 2	1.63	151	1	2.81	.44
2 to 3	2.64	72	1	2.90	.55
3 to 4	3.70	14	1	2.90	.63
Over 4	4.87	2	1	4.00	.68

The significance of this study may be seen by comparing group 1 with group 3. Hauling an average distance of 2.6 miles in comparison with an average distance of 0.8 mile increased the cost 15 cents per ton. If the grower obtained an average return of 12 tons per acre, this difference would make a total increase of $1.80 per acre. As the distance increased, the cost per acre increased throughout all of the groups. Only two records were obtained in group No. 5, hence it would scarcely be fair to compare this group with No. 1, in which 93 men reported on hauling a distance of approximately 1 mile. It may be observed, however, that the average cost for group 5, with a 12-ton yield, would be $3.36 per acre more than the cost involved in hauling beets under the conditions stated for group No. 1.

COST OF PRODUCING SUGAR BEETS.

The total cost figures were classified and compiled under three distinct divisions, viz, (1) labor, (2) materials, and (3) other costs. In computing the various costs a weighted average was used. The cost per acre was found by dividing the total costs by the number of acres grown, and the cost per ton by dividing by the total number of tons produced.

LABOR COSTS.

The operators' labor, horse labor, and contract labor, when added together, gave the total labor costs for the respective districts in 1914 and 1915. This also includes man labor hired by the day or by the month. The rate per hour, or the contract rate used in obtaining the final results, has been explained fully in connection with the practice of growing beets.

Table XXIV.—*Labor costs for three Colorado districts.*

District.	Year.	Number of farm records.	Total acres in beets.	Cost per acre.	Cost per ton.
Greeley	1914–15	195	5,028.40	$39.17	$2.53
Fort Morgan	1915	66	2,455.50	37.00	2.71
Rocky Ford	1914–15	106	2,428.95	38.34	2.95

The highest labor cost per acre ($39.17) was reported for the Greeley area (Table XXIV). Fort Morgan growers were $2.17 per acre below this average, but it will be seen that the average cost per ton was greater for Fort Morgan than for Greeley. Yield per acre was the factor that controlled the cost per ton in these districts.

In discussing these labor costs, it should be borne in mind that the hand work or the contract labor constituted a considerable proportion of the total labor costs. The standard contract rate for districts in northern Colorado was $18 per acre, plus a bonus of 25 cents per ton for each ton over an average yield of 12 tons per acre. For a 15-ton average this would necessitate the payment of $18.75 per acre. If all the growers represented in the Greeley district had paid for the hand labor on this basis, this item would have approximated 47 per cent of the total labor charge. It will be remembered that several growers did their own hand labor at a lower cost for this work than the contract price, hence the total charge for the latter in the district was reduced slightly for this reason.

MATERIALS.

The materials that were bought or used in the production of beets within these districts included seed, manure, poison for control of insects, and water. These items were therefore treated separately as a part of the expense incident to raising this crop (Table XXV).

TABLE XXV.—*Cost of materials for three Colorado districts.*

District.	Year.	Number of farm records.	Total acres in beets.	Cost per acre.				Cost per ton.
				Seed.	Manure.	Water.	Total.	
Greeley	1914–15	195	5,028.40	$1.80	$5.50	$0.51	$7.83	$0.50
Fort Morgan	1915	66	2,455.50	2.11	3.46	.57	6.16	.45
Rocky Ford	1914–15	106	2,428.95	2.16	2.93	.50	5.60	.43

Beet seed.—The sugar company usually arranges to maintain a supply of seed sufficient for one or two seasons in advance. War conditions have interfered seriously with the importation of seed from abroad, consequently the ordinary stocks have been depleted and it has been necessary to urge the use of less seed per acre in starting the crop.

Seed was planted at the rate of 21 pounds per acre at Rocky Ford, 18.9 pounds per acre at Fort Morgan, and 18 pounds per acre at Greeley. A charge of 10 cents per pound was made for the beet seed. This would seem to indicate that the actual cost for seed in the Fort Morgan area should be $1.89 per acre in place of $2.11, as shown in the foregoing table. However, there was some replanting in each district and the cost of the seed used for this purpose, when charged to the entire acreage for each region, made the acre cost in 1914 and 1915 slightly more than the standard cost. There was a difference of 36 cents between the acre charge for seed as reported by the Greeley operators and that given for the Rocky Ford group.

Manure.—The value of the farm manure applied was estimated by each grower and served as a basis in computing the amount that should be charged against the 1914 and 1915 sugar beet crop. The Greeley and Fort Morgan growers manured essentially 50 per cent of the land in beets, whereas in the Rocky Ford section only 41 per cent of the beet land was treated. There was considerable variation in the rate of application. The Rocky Ford group had the lowest rate, 11.8 tons per acre, while the Greeley growers had the highest, 18.6. The Fort Morgan operators applied manure at the rate of 14.3 tons per acre.

Spray material.—Relatively few farms expended any money for the purchase of materials to use in destroying insects or to apply for the purpose of controlling plant diseases. Grasshopper poison was put out by 10 operators in Otero County, by 4 in Weld County, and by 5 in Morgan County. This item of cost, though exceedingly small, must not be ignored entirely, as each grower may at some time in his experience be called upon to do this kind of work. It frequently happens that a little money expended for poison insures a much better yield.

Irrigation water.—The annual charge for water did not differ greatly in the three districts under observation. The average for all districts was slightly more than 50 cents per acre. Several irrigation companies operate in each area, and some growers obtain water from two or more sources. This feature was given careful consideration, and an attempt was made to compute a fair charge for the annual use of water. Some of the original ditches have comparatively low water rates on account of early priorities. While there may be wide variation in the annual water assessment paid by individual growers who are receiving their supplies from different sources there is uniformity in the farms served by a given canal and the average charges for each district are also quite uniform.

OTHER COSTS.

There are certain expenses that must be carried by the farm as a whole, of which each enterprise must bear a just proportion. The solution of this problem in connection with a single enterprise involves a careful study of the entire business of the farm. Having obtained a true perspective of the relationships that exist between the various branches of the business, it was possible to distribute such costs as insurance and taxes, interest on land and land rental, machinery charges, and overhead expense on an equitable basis (Table XXVI).

TABLE XXVI.—*Other costs for three Colorado districts.*

District.	Year.	Number of farm records.	Total acres in beets.	Cost per acre.					Cost per ton.
				Insurance and taxes.	Interest and rent.	Machinery.	Miscellaneous.	Total.	
Greeley	1914–15	195	5,028.40	$0.85	$21.21	$2.06	$1.41	$25.53	$1.63
Fort Morgan	1915	66	2,455.50	1.05	16.65	2.85	1.29	21.84	1.60
Rocky Ford	1914–15	106	2,428.95	.74	16.87	2.00	1.32	20.93	1.61

Insurance and taxes.—Each operator gave a report on the insurance and taxes paid during the year. These expenses were apportioned to the different enterprises of the farm and the amount to be assigned to sugar beets was determined. The insurance and taxes paid by tenant farmers in 1914 and 1915 were only personal taxes and were relatively small in comparison with the amount paid by owners or owners renting additional land, who had a land tax to pay in addition to personal property tax. A group of farms including a large number of tenants would show therefore a comparatively small charge under the heading "Insurance and taxes," but the proportion included with rent would balance up this apparent deficiency. The Greeley and Rocky Ford groups were almost equally divided between owner and tenant farms, while the Fort Morgan district gave only 42 per cent of straight tenant operators. This explains the slight difference in the amounts given for insurance and taxes in the three districts.

Interest and rent.—The investment of a given amount of capital in land should bring a definite return each year. When money is borrowed and farm land secures this loan, interest must be paid. If money is worth 7 per cent and land is valued at $200 per acre, then the crop which is grown upon that soil should be charged with $14 as interest.

In each of these districts estimates showing the value of farm land were secured and used in figuring the interest charge. Land rental was computed from the amounts received by the landlord in 1914 and 1915 as a direct cash payment or indirectly through the sale of sugar-beets. The Greeley group had the highest interest and rental cost per acre ($21.21). The Fort Morgan and Rocky Ford operators had an average interest and rental cost approximating $17 per acre.

Some cash is required to meet the operating expenses of the farm during the growing season. A part of the total cost of the contract labor must be paid when the bunching and hoeing are completed. Money for this purpose is frequently provided by the sugar company, but principal and interest must be met when the crop is harvested. The interest on this loan was included along with interest and rent.

Machinery.—These costs not only involve interest on the original investment in machinery, but also embrace depreciation and annual repairs. There are a few implements, such as the beet drill, topping knives, and the lifter, that are used exclusively on sugar beets. Other equipment, like the plow, harrow, disk, leveler, cultivator, wagons, etc., may be used for several crops, hence the costs that are involved must be apportioned according to the relative importance of the enterprises. This expense stands second in this group of costs. In the Greeley and Rocky Ford sections the machinery costs per acre were practically identical. The sugar beet is by far the most important crop at Fort Morgan, hence the machinery charge is somewhat greater than in the other two districts, where more enterprises shared this cost.

Miscellaneous expense.—Some of the expenses of the farm, such as telephone charges, office supplies, etc., are general in nature and are not applicable to any special enterprise. They must therefore be carried by the farm as a whole. To make provision for these items, a 3 per cent charge was made on the basis of labor and material costs combined. If the labor and materials amounted to $60 per acre, 3 per cent of this sum would be $1.80. This would be taken as a part of the total cost of producing the crop. It will be seen that the overhead expense for the three Colorado districts did not vary greatly.

SUMMARY OF COSTS.

In Table XXVII is shown a summary of costs in 1914 and 1915 for the three districts. The highest cost per acre was found in the Greeley district, but as this region was credited with the highest average yield, these growers had the lowest cost per ton. The cost per acre was $7.66 greater in the Greeley district than in the Rocky Ford section, but, the Greeley farmers produced sugar beets at a cost of $4.66 per ton, which was 33 cents per ton less than the cost at Rocky Ford.

TABLE XXVII.—*Summary and distribution of costs for three Colorado districts.*

District.	Year.	Yield per acre.	Cost per acre.	Cost per ton.	Distribution of costs.		
					Labor.	Materials.	Other costs.
					Per cent.	*Per cent.*	*Per cent.*
Greeley	1914–15	15.57	$72.53	$4.66	54.3	10.7	35.0
Fort Morgan	1915	13.65	65.00	4.76	56.9	9.5	33.6
Rocky Ford	1914–15	12.99	64.87	4.99	59.1	8.6	32.3

Labor costs constituted the most important part of the expense in producing sugar beets. In the Rocky Ford district this amounted to 59.1 per cent. Greeley growers had the lowest percentage under this heading. Materials constituted from 8.6 to 10.7 per cent of total cost, and other costs approximately one-third.

LABOR REQUIREMENT.

As already stated the labor requirement in the production of sugar beets includes man, horse and contract labor. Since it is the general practice to hire a part of the work done at a stipulated price per acre, this contract labor is usually treated as a direct cash outlay against the beet crop. This item was converted to man hours by dividing the cash outlay per acre by 25, the cost per hour in cents. Table

XXVIII contains the total labor requirement per acre for the three districts represented in this study.

TABLE XXVIII.—*Labor requirement in producing an acre of sugar beets.*

District.	Year.	Acres grown.	Yield per acre.	Hours per acre.	
				Man.	Horse.
			Tons.		
Greeley	1914–15	5,028.4	15.57	123.9	104.5
Fort Morgan	1915	2,455.5	13.65	118.1	103.0
Rocky Ford	1914–15	2,429.0	12.99	117.3	132.7

It will be seen that there is little variation in the number of man hours. There is a difference of about 6 hours of man labor between Greeley and Fort Morgan. A greater variation is apparent in the horse labor expended. At Rocky Ford about 30 hours more horse labor were necessary than at Greeley or Fort Morgan. A study of the farm practice tables shows that the tillage operations were performed a greater number of times at Rocky Ford than at Greeley or Fort Morgan. This was true, especially with such work as crowning, disking, leveling, cultivating, and furrowing out. Ordinarily the hours of man labor will exceed the hours of horse labor in the production of sugar beets. However, one of these regions furnishes an exception to this rule.

PROFIT.

In the last analysis the success of a given farm depends not so much upon the profit that may be derived from a single enterprise as it does upon the balance and stability of the entire organization. A certain enterprise on the farm may bring an exceedingly small profit at the end of the year, and in comparing the returns with the income from other crop or live-stock enterprises, the operator might conclude that the one showing a narrow margin would have to be discarded, but in reaching this decision he may overlook the fact that the industry in question enables him to utilize hands and teams to advantage when otherwise they might be idle and merely entailing expense. Large direct profits from a single crop should not be the determining factor in leading the operator to increase his acreage greatly, since the seemingly less profitable enterprises may be contributing much to his success; indeed, failure might follow if they were dropped. This is merely another way of saying that farming is a complex business, and that in order to attain the highest success each enterprise should be considered not only in its relationship to others but also in its bearing upon the farm policy as a whole. Cost figures should be discussed in the same manner. However, it may be pointed out that estimates can be obtained more readily with a single crop than with all enterprises combined (Table XXIX).

TABLE XXIX.—*Average returns and margin above cost in producing sugar beets, 1914–15.*

District.	Yield per acre.	Receipts, beets and tops per acre.	Cost per acre.	Margin per acre.		
				Beets.	Tops.	Total.
Greeley	15.57	$92.44	$72.53	$16.93	$2.98	$19.91
Fort Morgan	13.65	81.66	65.00	12.70	3.96	16.66
Rocky Ford	12.99	67.36	64.87	−.12	2.61	2.49

During the years 1914–15 the 195 Greeley farmers represented in this study received an average price of $5.74 per ton for sugar beets. The 66 Fort Morgan growers were paid $5.69 per ton as an average for the year 1915. The 106 Rocky Ford growers realized $4.87 per ton as an average for the crop years 1914–15. In the latter district the beet crop was grown at a loss, provided no credit is given for beet tops. This by-product had an estimated value of $2.61 per acre, and when this was considered there was a margin of $2.49 per acre. Greeley growers secured a margin of almost $17 per acre on sugar beets alone. The sugar beets were sold largely on the basis of sugar content. Selling beets on a percentage basis involved the use of a sliding scale.[1]

SUMMARY OF COSTS BY TENURE.

The records for the three Colorado districts were classified by tenure, and cost figures were compiled for three groups, namely, owners, renters, and owners renting additional land. In the three districts there were 155 owners, 182 renters and 30 owners renting additional land, the latter mostly in the Greeley district. The distribution of these farms with the costs for each group is given in Table XXX.

---

[1] This method is illustrated in the following scale, adopted by one of the sugar companies for the 1915 crop (northern Colorado):

Scale of prices adopted by a Colorado sugar company in 1915.

Price paid for beets per ton.	Sugar content.		Price paid for beets per ton.	Sugar content.	
	Minimum.	Maximum.		Minimum.	Maximum.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
$5	12	14	$5.875	16.5	17
$5.125	14	14.5	$6	17	17.5
$5.25	14.5	15	$6.125	17.5	18
$5.50	15	15.5	$6.25	18	18.5
$5.625	15.5	16	$6.375	18.5	19
$5.75	16	16.5	$6.50	19	19.5

12½ cents per ton additional is paid for each one-half per cent above 19½ per cent.

TABLE XXX.—*Summary of costs by tenure (1914–1915).*

District.	Owners.			Renters.			Owners additional.		
	Number.	Total of all costs.		Number.	Total of all costs.		Number.	Total of all costs.	
		Per acre.	Per ton.		Per acre.	Per ton.		Per acre.	Per ton.
Greeley	78	$70.23	$4.36	96	$74.40	$4.95	21	$71.15	$4.37
Fort Morgan	33	62.48	4.52	28	67.54	4.95	5	62.42	4.99
Rocky Ford	44	69.76	5.20	58	62.54	4.88	4	63.28	5.52

In the Greeley district the farm owners had a higher cost per acre for labor and manure, and they paid more for insurance and taxes than the tenant farmers. The interest charge in the owner group averaged $14.18 per acre, whereas rent on the tenant farms averaged $25.82. It has been pointed out that this latter item not only includes enough to cover interest on capital but also to meet taxes on land and provide for a certain amount of upkeep. Sugar-beet land is rented quite generally in the Greeley area on a share basis, the landlord receiving one-quarter of the crop. This system does not carry the same degree of risk for the tenant as a cash rental; however, when the crop produces a good yield a greater benefit accrues to the landlord.

The cost per acre and per ton in the Greeley and the Fort Morgan districts was much greater on the tenant farms than the costs reported for the owner farms, and the owners obtained a better average yield than the tenants. Owners renting additional land in the Greeley district had about the same costs as owners. It will be observed that in the Rocky Ford area the position of owners and tenants as to total costs was reversed, the owners having a higher acre cost and a higher cost per ton than the tenants. The owners, however, had a better average yield than the tenants.

COST IN RELATION TO ACREAGE AND YIELD.

The question is sometimes asked whether the grower who is producing a comparatively small acreage of sugar beets has a better chance to secure higher yields than the operator who plants a relatively large acreage to this crop. What effect does the production of a large acreage have upon yield and cost? Three hundred and sixty-seven farms in this survey were classified according to the acreage grown, and also with reference to yield per acre; and the average cost per acre and cost per ton were determined. The results are shown in Table XXXI.

TABLE XXXI.—*Relation of acreage and yield per acre to cost per acre and per ton (1914–15).*

	10 tons or less.			11 to 15 tons.			16 tons and over.		
	Number of farms.	Cost.		Number of farms.	Cost.		Number of farms.	Cost.	
		Per acre.	Per ton.		Per acre.	Per ton.		Per acre.	Per ton.
10 acres or less	12	$72.31	$7.72	23	$71.90	$5.64	24	$83.22	$4.87
11 to 20 acres	10	62.38	7.92	46	66.77	4.99	40	78.25	4.42
21 to 40 acres	21	57.35	6.30	80	65.78	4.99	56	75.09	4.21
41 acres and over	1	49.85	4.92	33	63.86	4.68	21	75.82	4.43

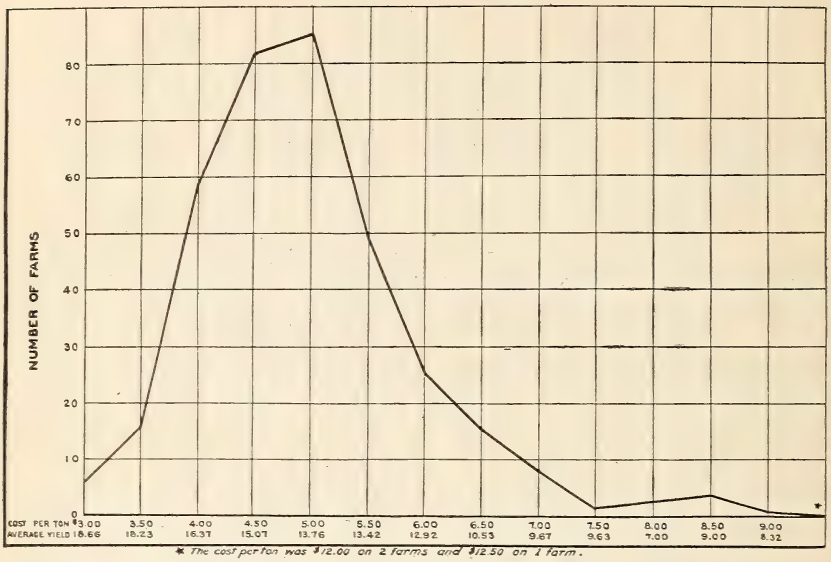
There were 59 farmers who planted 10 acres or less to sugar beets. Twenty-one per cent of these operators had an average yield of 10 tons or under per acre, and these beets were grown at a cost of $7.72 per ton. Approximately 38 per cent of these farms made average yields that varied from 11 to 15 tons per acre. The cost per acre was essentially the same as in the first group but the higher yield enabled them to reduce the cost per ton. Even with this advantage the margin of profit was comparatively small. Forty-one per cent of the farms raising 10 acres or less secured average yields of 16 tons and over. The cost advanced about $11 per acre over the preceding groups, but the higher yields brought the cost per ton down to $4.87.

There were 96 farmers who planted from 11 to 20 acres to beets. Ten per cent of these men produced the crop at a loss. Increasing the yield per acre within this group produced the same effect as in the preceding list of farms. Where the average yield was 16 tons or over, the maximum cost per acre for these farms was attained, but the cost per ton was only $4.42.

There were 157 farms with beet fields that varied from 21 to 40 acres. Thirteen per cent of these operators produced the crop at a loss. The lowest cost per ton was reached by 56 farms with an average yield of 16 tons and over.

The last group contained 55 farms with 41 acres and over of beets. There were no failures in this class. One man had a yield of 10 tons or under, but the cost per ton was only $4.92. It would seem that the man with the small acreage per farm can not afford to have a low yield, whereas the man who is cultivating 41 acres of beets or over has a chance to break even with a crop of only 10 tons per acre. Good yields aid in securing a low cost per ton. This is essential if the grower expects a substantial profit. This point is illustrated even more effectively in figure 29. This diagram shows that the lowest cost—$3 per ton—was reached by six operators who produced an average yield of 18.66 tons per acre. The highest cost per ton shown in this investigation was $12.50, which was on a farm with a yield of only 5 tons per acre.

There were 297 farmers who produced beets at a cost of $5.50 per ton or less. The average price received was slightly greater than this amount. It will be seen, therefore, that 70 growers in these three districts produced sugar beets at a loss. An average price of $6.50 per ton would have added 42 farmers to the profit group. There will always be a small group of inefficient operators or growers who for one reason or another will fail to make a profit on this crop (fig. 30).



* The cost per ton was $12.00 on 2 farms and $12.50 on 1 farm.

FIG. 29.—Frequency curve showing the distribution of farms in relation to the cost per ton and yield per acre, 1914–15.

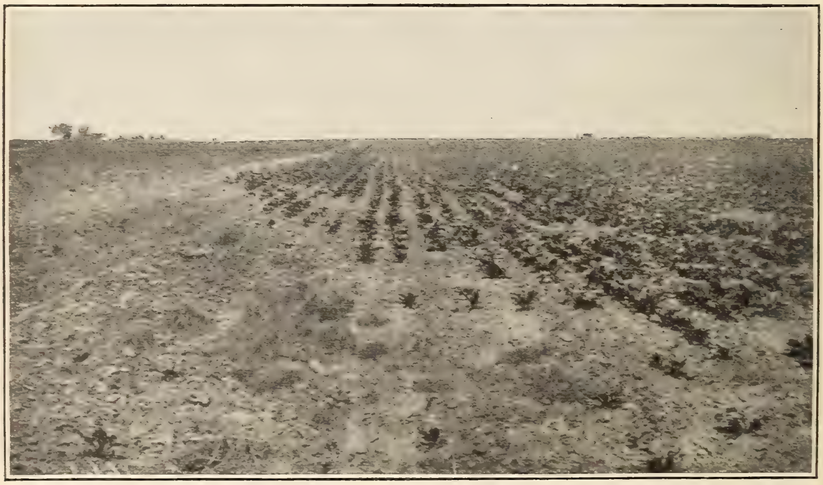


FIG. 30.—A portion of the crop has been lost on account of improper use of irrigation water.

Good yields are invariably associated with thorough tillage methods and a well-regulated cropping system. If the returns on a given farm are below the average for the district, it is highly probable that some improvement can be made by giving attention to the following points: (1) Better utilization of the manure which accumulates on the farm; (2) increasing the supply of organic matter in the soil through green-manuring crops; (3) more thorough tillage, not only in plowing, but also in the subsequent preparation of the seed bed; (4) exercising greater care in doing the handwork, expecially the bunching and thinning; (5) better cultivation; (6) the proper use of water. A good rotation should be adopted and adhered to systematically.

VALUE OF BEET TOPS.

Beet tops may be considered as a by-product of the beet-sugar industry. After the beets are pulled the tops are cut off squarely just below the crown at the base of the bottom leaf. The crown part of the beet, together with the leaves, is left upon the field. Sometimes the topping is done in such a manner as to leave the tops in small piles. By following this plan they are not tramped into the soil when the beets are loaded and hauled from the field. Beet tops make excellent feed for all classes of stock and can be used to advantage by most growers in the fall of the year. In this investigation an attempt was made to get the growers' estimate with reference to the value of beet tops in 1914 and 1915. The figures obtained were based upon actual value when sold or upon the value of hay and roughage saved through the use of tops. Seventy-four per cent of the operators fed the tops to their own stock. A few men fed a part of the tops and sold the remainder, while a few other men sold all the tops (Table XXXII).

TABLE XXXII.—*Disposition and estimated acre value of sugar-beet tops.*

District.	Number of farms.	Year.	Per cent fed.	Value when fed.	Per cent fed and sold.	Value [a] when fed and sold.	Per cent sold.	Value when sold.
Greeley	195	1914–15	73	$3.07	12	$2.70	15	$2.97
Fort Morgan	66	1915	65	4.31	21	4.25	14	3.77
Rocky Ford	106	1914–15	79	2.82	8	2.65	13	2.54
Total	367	....	74	3.35	12	3.30	14	3.07

[a] Part of crop was fed on farm and remainder was sold. In the latter instance the tops were invariably fed in the field where the beets were grown.

The average values for the Fort Morgan area were uniformly higher than the values for the Greeley and Rocky Ford districts. Sugar beets are relatively more important in the management of the farm at Fort Morgan than in the other two districts, and for this reason greater value is placed upon the tops. Furthermore, the district in question has a winter with less snow than the others, and the relative loss is undoubtedly smaller on this account. Moreover, many cattle are brought in from the ranges for feeding or wintering. These facts taken together may explain the higher average value reported for this district.

The estimated farm value of beet tops was greater than the selling value in each of the districts. The man who feeds tops to his own stock evidently believes that they are worth more to the farm than the customary selling price.

RELATIVE IMPORTANCE OF BEET RECEIPTS.

A comparison of the crop, live stock, and miscellaneous receipts of the farms studied, for the crop year 1915, will convey to the reader some idea of the relative importance of the sugar beet (Table XXXIII). In the Greeley area, sugar beets contributed 32 per cent of the total farm receipts and almost one-half of the crop receipts. The importance of the sugar beet in the Fort Morgan district is shown by the fact that this crop afforded 61.7 per cent, or almost two-thirds, of the total farm receipts. On the Rocky Ford farms the sugar beet was also the most important cash crop.

TABLE XXXIII.—*Average beet receipts per farm in comparison with other farm receipts in 1915.*

District.	Number of estimates.	Average total receipts per farm.	Per cent of total receipts from—				Per cent of crop receipts from beets.
			Crops.	Live stock.	Miscellaneous.	Beets.	
Greeley	90	$7,436.62	71.4	27.4	1.2	32.1	45.0
Fort Morgan	66	4,763.49	69.4	29.6	1.0	61.7	88.9
Rocky Ford	37	2,754.95	74.4	22.2	3.4	52.8	70.8

VARIATION IN FARM PRACTICE.

Although certain field methods in preparing the seed bed for sugar beets and in tending and harvesting the crop are common to all growers, the desired results are often accomplished in a number of different ways. The condition of the soil at the time the land is worked sometimes determines the character of the operations necessary to put the ground in shape for planting. Some land may have to be disked and harrowed with a spring-tooth and a spike-tooth harrow, while other land may require only spike-tooth harrowing. The same is true for rolling the land. The climatic conditions usually govern the method of handling the growing crop, while certain economic factors, together with climate, have much to do in shaping the field operation and practice in harvesting and hauling the crop.

The blocking and thinning are usually contracted, but some farmers do their own work in hoeing the crop. Occasionally all of the handwork will be done by the farmer, his family, and hired hands.

The number of times the crop is cultivated varies considerably, as well as the number of irrigations. Then, too, the practice of harvesting depends on the available supply of labor. A portion or all of this work may be done by the day or may be contracted by the ton.

Some of these features are illustrated in Tables XXXIV, XXXV, and XXXVI, which show variations in farm practice for 10 representative farms in each district.

TABLE XXXIV.—*Variations in farm practice on 10 farms at Rocky Ford.*

Operations.	Farm No. 1.	Farm No. 2.	Farm No. 3.	Farm No. 4.	Farm No. 5.	Farm No. 6.	Farm No. 7.	Farm No. 8.	Farm No. 9.	Farm No.10.
	Times over	*Times over.*	*Times over.*	*Times over.*	*Times over.*	*Times over.*	*Times over.*	*Times over.*	*Times over.*	*Time over.*
Plowing	1	1	1	1	1	1	.6	1	1	......
Disking	2	......	1.5	......	......	......	......	1	......	2
Leveling	4	2	3	4	2	2	2	3	4	1
Harrow:										
Spike	3	7	3	3	4	2	4	2.5	2	2
Spring	......	......	......	......	......	......	......	......	......	......
Rolling	......	......	......	1	......	......	......	1	......	......
Ditching:										
Plow	......	2	......	......	......	......	1	2	......	......
Shovel	......	......	1	1	1	1	1	1	......	1
Planting	1	1	1	1	1	1	1	1.5	1	1
Harrowing beets	......	1	2	......	1	......	......	......	......	......
Rolling beets	.2	......	1	.2	1	......	1	.3	1	......
Spraying G. H. poison	......	1.4	......	......	......	......	......	2	......	2
Cultivating	5	2.1	6	4	5	4	6	4	4	4
Furrowing	1	2.1	2	4	1	1	3	3	4	1
Sledding	......	1	1	......	2	.4	......	......	1	......
Irrigating	2	4	2.5	3	2	1.4	3	3	5	3
Block and thin	[a] C	C	C	C	C	C	C	C	C	C
Hoeing:										
First	C	1	1	1	1	C	C	1	1	1
Second	C	1	......	1	......	C	1	1	1	1
Third	......	......	......	......	......	......	......	......	1	......
Topping and loading	C	C	C	C	C	C	C	C	C	1
Lifting	1	1	1	1	1	1	1	1	1	1
Pitting	C	......	.2	.2	.1	......	......	......	......	......
Hauling	1	C	1	1	1	1	1	1	1	1
Manuring	[b] .3	.2	.4	.5	.3	.2	.2	.4	.4	.1
Hauling manure from town	......	......	.4	......	......	.2	......	......	......	......
Crowning alfalfa	.1	1	......	......	......	......	......	......	......	......
Man-hours per acre	42	57	51	57	64	36	55	57	49	97
Horse-hours per acre	124	99	125	129	143	102	123	150	110	89
Yield per acre (tons)	15	7.8	11.5	12.5	14	10.6	12	11.9	12	14
Total cost per acre	$65.78	$58.62	$62.00	$68.84	$62.20	$58.02	$62.48	$63.27	$61.52	$58.71

[a] The letter C indicates that this operation was performed on a contract basis.

[b] Under the operation manuring, the fractional numbers indicate the portion of the beet acreage which received an application of barnyard manure. For instance, Farm No. 1 in the Rocky Ford district, put farm manure on three-tenths of the beet land. On the same farm one-tenth of the beet acreage was located on a field that was previously in alfalfa. The initial operation on this tract was crowning. After the beets had been planted the operator used the roller on two-tenths of the acreage.

TABLE XXXV.—*Variations in farm practice on 10 farms at Fort Morgan.*

Operations.	Farm No. 1.	Farm No. 2.	Farm No. 3.	Farm No. 4.	Farm No. 5.	Farm No. 6.	Farm No. 7.	Farm No. 8.	Farm No. 9.	Farm No. 10.
	Times over.	*Times over.*	*Times over.*	*Times over.*	*Times over.*	*Times over.*	*Times over.*	*Times over.*	*Times over.*	*Times over.*
Plowing	1	1	1	1	1	1	0.6	1	1	1
Disking	......	......	......	1	......	.7	......	2	......	......
Leveling	1	3	2	2	1	3	5	2	2	1
Harrow:										
Spike	3	2	4	2	4	3.5	5	4	4	6
Spring	......	......	......	......	......	......	......	......	......	......
Rolling	......	2	......	......	......	......	......	......	......	......
Ditching:										
Plow	2	......	......	......	1	1	2	......	2	1
Shovel	......	1	2	2	1	......	......	......	1	1
Planting	1.1	1	1	1.8	1	1	1	1.9	1	1
Rolling beets	......	......	.2	......	......	......	......	......	......	.2
Cultivating	4	3	6	4	6	4	5	7	5	5
Furrowing	1	1	1	1	2	1	2	1	1	1
Irrigating	2.5	3	3	4	2	2.5	4	3	2	2
Block and thin	[a] C	C	1	1	C	C	1	1	C	C
Hoeing:										
First	C	C	1	1	C	C	1	1	C	C
Second	C	C	1	1	C	C	1	1	C	C
Topping and loading	C	C	1	1	C	C	1	1	C	C
Lifting	1	1	1	1	1	1	1	1	1	1
Hauling	1	1	1	1	1	1	1	1	1	1
Manuring	[b] .7	.3	.4	.7	.5	.4	.4	.2	.3	.5
Hauling manure from town	......	......	......	......	......	......	......	......	......	......
Crowning alfalfa	......	......	......	......	......	.2	.4	......	.4	......
Man-hours per acre	46	48	113	140	36	42	111	132	46	50
Horse-hours per acre	106	115	82	99	110	106	131	112	119	79
Yield per acre (tons)	12.5	13.0	12.2	16.5	12.0	14.0	14.0	17.5	12.5	13.0
Total cost per acre	$64.47	$67.48	$54.80	$67.59	$59.49	$61.08	$66.14	$67.00	$63.57	$70.82

[a] See footnote, p. 57.

[b] See footnote, p. 57.

TABLE XXXVI.—*Variations in farm practice on 10 farms at Greeley.*

Operations.	Farm No. 1.	Farm No. 2.	Farm No. 3.	Farm No. 4.	Farm No. 5.	Farm No. 6.	Farm No. 7.	Farm No. 8.	Farm No. 9.	Farm No. 10.
	Times over.	*Times over.*	*Times over.*	*Times over.*	*Times over.*	*Times over.*	*Times over.*	*Times over.*	*Times over.*	*Times over.*
Plowing	1	1	0.2	1	1	0.5	......	0.6	0.6	1
Disking	......	......	......	......	......	1	......	......	......	......
Leveling	1	1	1	2	1	1.5	2	2	1	1
Harrow:										
Cyclone	......	......	......	......	......	......	......	......	......	......
Spike	5	2	1.7	2	4	3.5	......	5	2	2
Spring	......	......	1.5	2	......	2	2	2	......	......
Alfalfa renovator	......	......	......	......	......	......	......	......	.7	......
Rolling	......	1	.5	......	1	......	......	1	1	1
Ditching	......	1	1	1	.1	1	......	1	1	......
Shoveling	1	......	1	......	1	1	1	......	......	1
Planting	1	1.1	1.4	1	1	1	1	1.6	1	1
Harrow beets	......	......	......	......	......	......	......	......	......	......
Rolling beets	......	......	.2	......	1	......	......	.6	......	......
Spraying	......	......	......	......	......	......	......	......	3	......
Applying G. H. mixture	......	......	......	......	......	......	1	3	......	......
Cultivating	3	3	3	4	6	4	3	5	3	5
Furrowing	2	2	2	2	1	1	1	1	2	1
Sledding	......	......	......	......	......	......	......	......	......	......
Irrigating	4	4	4	3	5	3	3	3	4	2
Block and thin	[a] C	C	C	C	1	C	C	C	C	C
Hoeing:										
First	C	C	C	C	1	C	C	C	C	C
Second	C	C	C	C	1	C	C	C	C	C
Topping and loading	C	C	C	C	1	C	C	C	C	C
Lifting	1	1	1	1	1	1	1	1	1	1
Hauling	1	C	1	1	1	1	1	1	1	1
Manuring	[b] .5	.2	.2	.7	.6	......	.1	.1	.5	.3
Hauling manure from town	......	......	.2	......	......	......	......	......	......	......
Crowning alfalfa	1	.3	......	......	.4	......	......	......	......	......
Man-hours per acre	41	36	51	48	155	44	57	44	50	51
Horse-hours per acre	74	76	98	109	124	124	102	111	88	144
Yield per acre (tons)	19.0	16.0	16.7	19.0	14.0	14.0	13.5	15.0	17.0	19.5
Cost per acre	$72.25	$76.99	$76.27	$74.39	$73.40	$65.90	$68.78	$77.61	$80.83	$66.14

[a] See footnote, p. 57.

[b] See footnote, p. 57.

A review of these tables will show that some of the operations were not common to all farms. This was particularly true of such work as disking, harrowing with a spring tooth, rolling the land prior to planting, sledding out, and pitting sugar beets. Such major field operations as plowing, harrowing with a spike tooth, leveling, planting, cultivating, furrowing out, the handwork, lifting and hauling, are common to practically all farms. There may be a slight variation in the number of times each operation is performed.

Referring to the Rocky Ford summary table, it will be seen that a few farmers harrowed twice with the spike tooth, that others went over their fields three or four times with this implement, and that in one case the ground was harrowed seven times. When extra work is done, and this applies to several operations on the same farm, it will have a tendency to give a man and horse labor requirement somewhat above the average.

On a few farms it was necessary to do some replanting. If two-tenths of the field had to be reseeded, then the number of times over is indicated by 1.2. It will be noted that a small amount of work in addition to the hand labor, such as lifting and hauling, was done on a contract basis.

PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE RELATING TO SUGAR BEETS.

PUBLICATIONS AVAILABLE FOR FREE DISTRIBUTION.

Loss in Tonnage of Sugar Beets by Drying. (Department Bulletin 199.)
Field Studies of Crown-Gall of Sugar Beets. (Department Bulletin 203.)
Farm Practice in Growing Sugar Beets for Three Districts in Colorado, 1914–15. (Department Bulletin 726.)
Sugar Beet Growing Under Irrigation. (Farmers' Bulletin 567.)
Growing Sugar Beets under Humid Conditions. (Farmers' Bulletin 568.)
Leafspot: A Disease of Sugar Beets. (Farmers' Bulletin 618.)
Grasshoppers and Their Control on Sugar Beets and Truck Crops. (Farmers' Bulletin 691.)
Control of the Sugar-Beet Nematode. (Farmers' Bulletin 772.)
Sugar-Beet Sirup. (Farmers' Bulletin 823.)
More Beet and Cane Sugar Should be Produced. (Secretary's Circular 86, Part 3.)
Curly-Top of Beets. (Bureau of Plant Industry Bulletin 181.)
Conditions Influencing Production of Sugar-Beet Seed in United States. (Separate 503, Year Book 1909.)
Present Status of Sugar-Beet Seed Industry in United States. (Separate 695, Year Book 1916.)
Sugar Supply of the United States. (Separate 756, Year Book 1917.)

PUBLICATIONS FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C.

Sugar Beets, Preventable Losses in Culture. (Department Bulletin 238.) Price, 10 cents.
Sugar-Beet Thrips. (Department Bulletin 421.) Price, 5 cents.
Production of Sugar in United States and Foreign Countries. (Department Bulletin 473.) Price, 10 cents.
Sugar Beet, Culture, Seed, Statistics, etc. (Farmers' Bulletin 52.) Price, 5 cents.
Irrigation of Sugar Beets. (Farmers' Bulletin 392.) Price, 5 cents.
Development of Single-Germ Beet Seed. (Bureau of Plant Industry Bulletin 73.) Price, 10 cents.
Curly-Top Disease of Sugar Beet. (Bureau of Plant Industry Bulletin 122.) Price, 15 cents.
American Beet-Sugar Industry in 1910 and 1911. (Bureau of Plant Industry Bulletin 260.) Price, 25 cents.
Biochemical Study of Curly-Top of Sugar Beets. (Bureau of Plant Industry Bulletin 277.) Price, 5 cents.
Comparative Tests of Sugar-Beet Varieties. (Bureau of Plant Industry Circular 37.) Price, 5 cents.
Experiments with Sugar Beets in 1893. (Bureau of Chemistry Bulletin 39.) Price, 5 cents.
Experiments with Sugar Beets in 1897. (Bureau of Chemistry Bulletin 52.) Price, 20 cents.
Influence of Environment Upon Composition of Sugar Beet, 1900. (Bureau of Chemistry Bulletin 64.) Price, 5 cents.
Influence of Soil and Climate Upon Composition of Sugar Beet, 1901. (Bureau of Chemistry Bulletin 74.) Price, 5 cents.
Influence of Environment Upon Composition of Sugar Beet, 1903. (Bureau of Chemistry Bulletin 95.) Price, 5 cents.
Influence of Environment on Composition of Sugar Beet, 1904, with Summary of Five-Year Investigation. (Bureau of Chemistry Bulletin 96.) Price, 5 cents.
Analyses of Sugar Beets, 1905–1910, with Methods of Sugar Determination. (Bureau of Chemistry Bulletin 146.) Price, 10 cents.
Brief Account of Principal Insect Enemies of Sugar Beet. (Bureau of Entomology Bulletin 43.) Price, 5 cents.
Utilization of Residues from Beet-Sugar Manufacture in Cattle Feeding. (Separate 137, Year Book 1898.) Price, 5 cents.
Progress of Beet-Sugar Industry in United States in 1900. (Report 69.) Price, 10 cents.
Progress of Beet-Sugar Industry in United States in 1905. (Report 82.) Price, 15 cents.
Progress of Beet-Sugar Industry in United States in 1906. (Report 84.) Price, 15 cents.
Progress of Beet-Sugar Industry in United States in 1907. (Report 86.) Price, 10 cents.
Progress of Beet-Sugar Industry in United States in 1908. (Report 90.) Price, 10 cents.
Progress of Beet-Sugar Industry in United States in 1909. (Report 92.) Price, 10 cents.